

Jennison - Wright Site

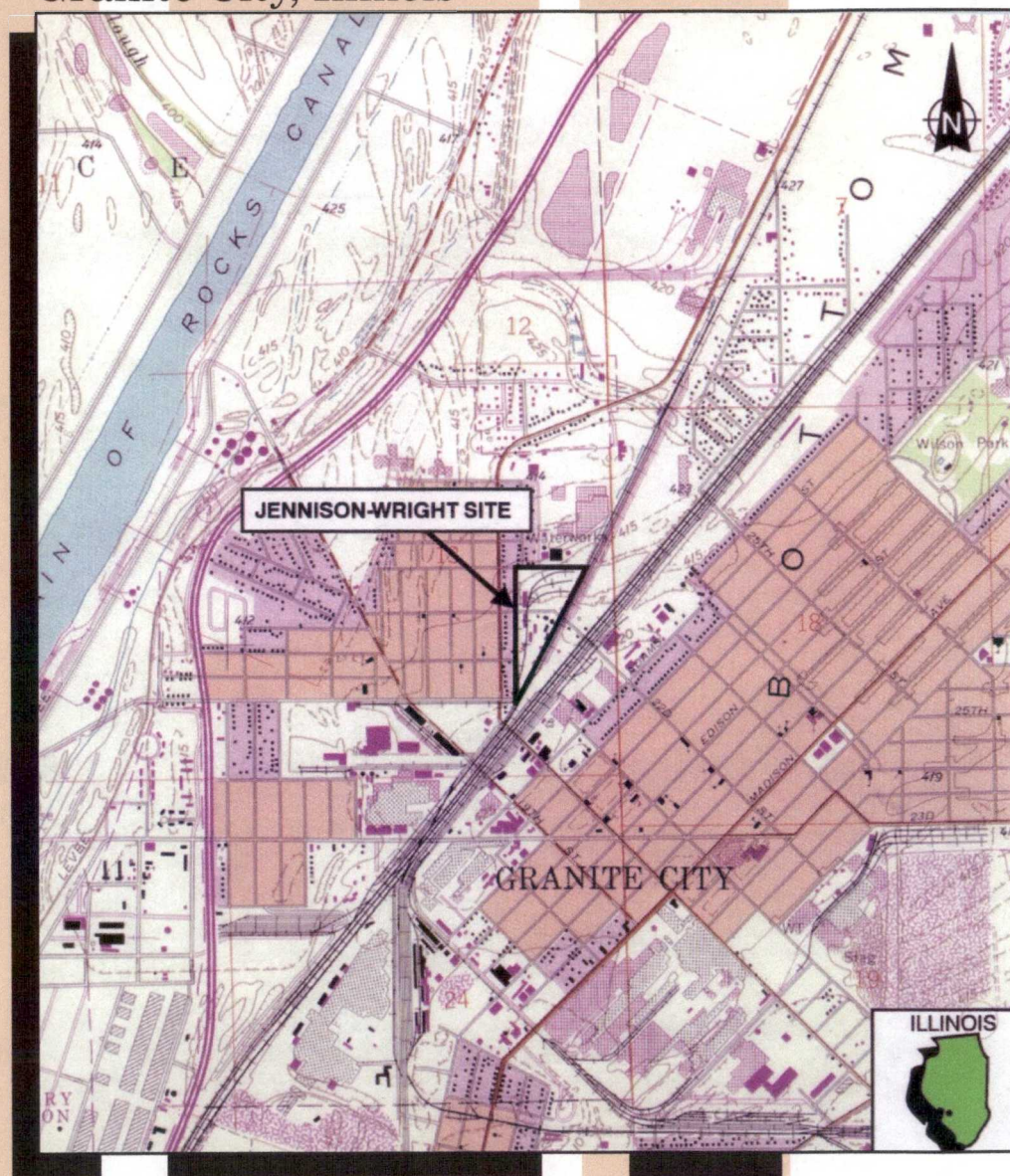
Engineering Evaluation/Cost Analysis

US EPA RECORDS CENTER REGION 5



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Granite City, Illinois



July 1999
Volume 1 - Text

prepared by:



**Engineering Evaluation/
Cost Analysis Report
Jennison-Wright Site
Granite City, Illinois**

Volume 1

July 1999

Prepared for:

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

Bureau of Land

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E & E

Ecology and
Environment, Inc.

IEPA

Illinois Environmental
Protection Agency

EE/CA

Engineering
Evaluation/Cost Analysis

CERCLA

Comprehensive
Environmental
Response,
Compensation, and
Liability Act of 1980

SARA

Superfund Amendments
and Reauthorization Act

JW site

Jennison-Wright site

PCP

pentachlorophenol

Executive Summary

Ecology and Environment, Inc. (E & E), was tasked by the Illinois Environmental Protection Agency (IEPA) to perform an Engineering Evaluation/Cost Analysis (EE/CA) for a non-time-critical removal action under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA, also known as Superfund), as amended by the Superfund Amendments and Reauthorization Act (SARA), at the Jennison-Wright site (JW site).

The JW site is located at 900 West 22nd Street in Granite City, Illinois. (Granite City, 6 miles northeast of downtown St. Louis, Missouri, is within the St. Louis metropolitan area.) The site is approximately 2 miles east of the Mississippi River. More precisely, the site is in the NE 1/4, SE 1/4, Section 13, T3N, R10W, of Madison County, Illinois.

The JW site is a defunct wood-treating facility that primarily treated railroad ties and wood block flooring using creosote, pentachlorophenol (PCP), and zinc naphthenate between the early 1900s and 1989. In addition, a driveway sealer, Jennite, was produced at the facility.

The creosote process was the first wood-preserving process used at the site, and was in operation between the early 1900s and 1989. The process involved pumping heated creosote into a treatment cylinder that was filled with either railroad ties or wood blocks. Heat and pressure were applied to the ties for 3 to 4.5 hours. Blocks were heated for approximately one-half hour. The bulk of the creosote was then pumped back to working tanks. A vacuum was applied to remove the remaining excess creosote, which was then also pumped back to the working tanks. At the conclusion of the treatment process, the cylinder door was opened, allowing residual creosote at the bottom of the cylinder to spill out onto the ground. Two in-ground cisterns were located at the rear of the cylinders. These cisterns collected creosote and surface water runoff that accumulated in the pit. Steam pipes were placed throughout the pit area to heat the spilled creosote and increase the flow of creosote into the cisterns. The contents of the cisterns were

Executive Summary

then pumped into an aboveground creosote/water separator. Recovered creosote was returned to the working tanks (or a storage tank), and the water was discharged to the municipal sewer system.

The PCP process operated from 1960 until 1986. Decorative wood blocks for flooring were treated with a preservative made up of a light petroleum distillate base and 5% PCP. The process involved placing wood blocks into the treatment cylinder, which was then filled with the PCP solution. Once the cylinder was full, PCP solution was forced back into the working tank by pressurizing the cylinder with air. A mercury vacuum was applied to the cylinder for 2.5 hours to draw out excess PCP solution. Air pressure was again applied to clean out the remaining PCP solution. At the conclusion of the treatment process, the cylinder door was opened allowing the residual PCP solution at the bottom of the cylinder to spill out onto the ground.

In 1986, the PCP process was replaced with a zinc naphthenate process. The equipment and the area used for the zinc naphthenate process remained unchanged from those used in the PCP process. The zinc naphthenate process operated until site operations were ceased in 1989.

In addition to the wood treatment, Jennite was produced at the site. Jennite was a coal tar pitch product used commercially as a pavement sealant. The basic components were montmorillonite clay, coal tar pitch, and a latex/rubber compound. The product was manufactured at the facility beginning in the early 1960s.

In addition to contamination in the process areas resulting from spilled creosote and PCP, the above operations resulted in the creation of several on-site waste disposal areas. These waste disposal areas are referred to as the Jennite pit, the 22nd Street lagoon, and Area H. Wastes are also present adjacent to tram rail across the site. The trams were used for the movement of lumber to treatment and storage areas.

NAPLs
non-aqueous-phase
liquids

ACM
asbestos-containing
material

An EE/CA support sampling investigation, which included the collection of surface soil, subsurface soil, sediment, and groundwater samples, was conducted to characterize the on-site areas of contamination. The investigation identified contaminated surface soils across the site, contaminated subsurface soils in the process and waste disposal areas, the presence of non-aqueous-phase liquids (NAPLs) in the vicinity of the 22nd Street lagoon, and contaminated groundwater. In addition, the existing on-site buildings were inspected and found to be in poor repair, and asbestos-containing material (ACM) was found to be present in most of these buildings.

SRE

Streamlined Risk
Evaluation

PAHs

polynuclear aromatic
hydrocarbons

RAOs

Removal Action
Objectives

NCP

*National Oil and
Hazardous Substances
Contingency Plan*

Streamlined Risk Evaluation

As part of this EE/CA, a human health and ecological Streamlined Risk Evaluation (SRE) was conducted. The purpose of an SRE is to estimate potential health risks related to human and wildlife exposure to contaminants present at a site in order to document the need for a removal action.

The overall conclusion of the human health SRE conducted for the JW site is that the site does pose unacceptable risks to human health in both current and hypothetical future use scenarios, and, therefore, a removal action at the JW site is warranted. The major factors causing the unacceptable risks for humans were:

- The presence of dioxins/furans and carcinogenic polynuclear aromatic hydrocarbons (PAHs) in site surface soils and potential exposures of current site visitors and future site workers;
- The presence of PCP in groundwater in the PCP process area, and the presence of carcinogenic PAHs, benzene, PCP, arsenic, 2,4-dimethylphenol, 2-methylphenol, and naphthalene in groundwater at the 22nd Street lagoon, coupled with the possible future use of site groundwater as a drinking water source for a future business established on the site. Other areas of groundwater contamination at the site do not pose unacceptable risks; and
- The presence of benzene and naphthalene in subsurface soils and the potential future short-term inhalation exposures of workers and nearby residents during periods of excavation/construction on the site.

The conclusions of the ecological portion of the SRE were:

- Habitat at the JW site is of a very low quality to wildlife;
- The site is located in an industrial and residential area. Only common wildlife accustomed to human activity and disturbance are likely to use the site; and
- The closest aquatic resource and ecologically sensitive areas to the JW site are located approximately 1 mile away and are not likely to be impacted by on-site contamination.

Removal Action Objectives

Removal Action Objectives (RAOs) were developed to provide a basis for the identification and evaluation of alternatives for the removal action. The RAOs were developed in accordance with the *National Oil and Hazardous Substances Contingency Plan* (the NCP) (EPA 1992a) and the United States Environmental Protec-

Executive Summary

tion Agency's (EPA's) *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (EPA 1993). In developing the RAOs, federal, state, and local Applicable or Relevant and Appropriate Requirements (ARARs), and other To Be Considered (TBC) requirements, were evaluated.

Based on the identified ARARs, and the need to reduce the unacceptable risks to human health, the following general RAOs were developed for the JW site:

- Prevent current nearby residents and potential future site workers from contacting, ingesting, or inhaling on-site soil and waste materials containing chemicals of potential concern (COPCs) that exceed the calculated risk-based cleanup objectives (CUOs);
- Prevent the continued release of contaminants to groundwater;
- Initiate active groundwater restoration;
- Abate regulated asbestos-containing material (RACM) present in the on-site buildings; and
- To the extent practical, remove NAPL from the subsurface in the vicinity of the 22nd Street lagoon.

Removal Action Scope

Using the SRE as a basis, proposed risk-based CUOs were calculated as 10^{-5} risk levels for soil and 10^{-6} risk levels for groundwater, or a target Hazard Quotient of 1 for both media. The proposed scope of the removal action consists of those areas of the site containing media with concentrations of COPCs above these risk-based CUOs. Media included in the scope of this EE/CA are soils considered to be listed hazardous wastes, soils and wastes, NAPLs, and groundwater. In addition, the site's buildings and silos, and miscellaneous items have been included within the removal action scope. Miscellaneous items include two empty underground storage tanks (USTs), two aboveground storage tanks (ASTs) which contain oil, an oil/water separator, various sumps and pits, liquids and sediments present in a concrete basin located in the creosote process area, a collapsed pole barn, tram rail, and debris piles.

Removal Action Alternatives

A limited number of removal action alternatives that address the above RAOs were identified and evaluated for each of the areas within the scope of this EE/CA. The alternatives are as follows:

EPA
United States
Environmental
Protection Agency

ARARs
Applicable or Relevant
and Appropriate
Requirements

TBC
To Be Considered
(requirements)

COPCs
chemicals of potential
concern

CUOs
cleanup objectives

RACM
regulated asbestos-
containing material

USTs
underground storage
tanks

ASTs
aboveground storage
tanks

Soils and Wastes

- Alternative S&W1: 24-Inch Permeable Soil Cover—Following removal of all aboveground structures and debris piles, and clearing and grubbing (which are items common to all soil alternatives), site grading would be performed in preparation for placement of a permeable soil cover. The existing site soils would be graded, and a colored (i.e., orange or yellow) fabric would be placed down to function as a boundary between the contaminated and clean soils. Next, 18 inches of common fill would be placed over the fabric, and topped with a 6-inch vegetated topsoil layer;
- Alternative S&W2: Landfarm—Soils and wastes containing COPCs above CUOs would be excavated and transported to an on-site landfarm cell for biological treatment. The landfarm cell would be constructed on the north side of the site, and would consist of a compacted clay liner, clay berms, a water drainage system, and a retention pond;
- Alternative S&W3: Low-Temperature Thermal Desorption (LTTD) — Soils and wastes containing COPCs above CUOs would be excavated and treated in a mobile LTTD unit set up on site; and
- Alternative S&W4: Off-Site Disposal — Soils and wastes containing COPCs above CUOs would be excavated and loaded into dump trucks for transportation to an off-site treatment, storage, and disposal (TSD) facility.

LTTD
Low-Temperature
Thermal Desorption

TSD
treatment, storage, and
disposal

Listed Hazardous Waste

- A component of all the soils and wastes alternatives is the removal and off-site disposal of soils that have been classified by IEPA as a listed hazardous waste (F032 or F034). These soils—in between the rails of the drip track—will be excavated and transported off site for disposal at an appropriately licensed facility.

Non-Aqueous-Phase Liquids

As part of the long-term groundwater treatment system that addresses both on-site and off-site groundwater contamination, alternatives were developed to facilitate the removal of NAPL from the saturated zone. These alternatives are as follows:

- Alternative NAPL1: Hot Water and Steam Flushing—Heated water and steam would be injected into the subsurface to mobilize NAPLs toward several extraction wells. Recovered

Executive Summary

NAPLs would be recycled or disposed of off site. Recovered groundwater would be heated, then reinjected into the subsurface for further NAPL flushing. Hot water and steam flushing would be implemented at the site using the Contained Recovery of Oily Waste (CROW) process. The CROW process is a patented treatment process which has been used at other wood-treating sites; and

CROW
Contained Recovery of
Oily Waste

R & M
Rubinos & Mesia
Engineers, Inc.

- Alternative NAPL2: Surfactant Flushing—This alternative is similar to hot water and steam flushing, with the main difference being that a surfactant (similar to a detergent), instead of water and steam, would be injected into the subsurface to mobilize the NAPLs toward several extraction wells. Surfactant flushing is considered an emerging technology.

Groundwater

- Alternative GW1: Natural Attenuation—In this alternative, naturally occurring biodegradation of groundwater contaminants would be allowed to continue. Periodic groundwater monitoring would be conducted;
- Alternative GW2: Enhanced In Situ Bioremediation—This alternative would enhance the naturally occurring biodegradation through the addition of oxygen and nutrients to the subsurface. Periodic groundwater monitoring would be conducted; and
- Alternative GW3: Ex Situ Biological Treatment—Groundwater would be pumped to an aboveground biological treatment system housed in a newly constructed treatment building. Treated groundwater would be reinjected into the subsurface or discharged to the Granite City sanitary sewer system. A fee would be assessed by the city for this discharge.

Buildings

There are five buildings and two silos on-site. The buildings are commonly referred to as the office building, the white building, the green building, the boiler building, and the transite building. The only hazardous material associated with the buildings is ACM. However, subsurface soil contamination may also be present beneath the floor slabs of the buildings. The ACM has been sampled, categorized, and quantified. E & E subcontracted Rubinos & Mesia Engineers, Inc. (R & M), to perform a structural assessment of the on-site structures. Based on R & M's report, it is recommended that the on-site buildings and silos be abated and demolished, with the debris being disposed of off-site. Demolition of the buildings and silos would be required in order to implement

Executive Summary

a removal action to address soils and wastes, NAPLs, and groundwater.

Miscellaneous Items

This group consists of two empty USTs; two ASTs containing oil; an oil/water separator containing sheened rainwater; various sumps and pits; liquids and sediments present within the concrete basin; a collapsed pole barn; scattered piles of concrete, scrap metal, and wood; and steel tram rail.

It is recommended that these items be removed from the site in order to implement a removal action to address soils and wastes, NAPLs, and groundwater, and to facilitate redevelopment of this abandoned site. Specifically, the two empty USTs should be excavated, removed, cleaned, and scrapped. The oil present in the two ASTs should be removed, containerized, and disposed of off site. The ASTs should then be cleaned and scrapped. The water present in the oil/water separator should be pumped out, containerized, treated by a carbon filter, and discharged to the sanitary sewer system. A fee would be assessed for this discharge. The oil/water separator should then be cleaned and scrapped. Liquid wastes present in the concrete basin and various sumps and pits should also be treated by carbon and discharged to the sewer. Sediments present in these structures should be treated in the same manner as the site's soils and wastes. The debris piles and collapsed pole barn would need to be segregated into wastestreams (i.e., steel, wood, concrete, and trash), with each wastestream being disposed of or recycled as appropriate. Tram track should be removed, cleaned of residual tar and soil, and scrapped.

PRSC
post-removal site control

Analysis of Removal Action Alternatives

The removal action alternatives were evaluated independently based upon three broad criteria (effectiveness, implementability, and cost) established by EPA. The effectiveness criterion evaluates the degree to which an alternative would mitigate threats to public health and the environment and achieves ARARs.

Implementability refers to the technical feasibility, administrative feasibility, and the availability of services and materials for each alternative. Finally, for each alternative, capital and post-removal site control (PRSC) costs were estimated, and the present worth of each alternative was calculated. Following the independent alternative evaluations against the three criteria, a comparative analysis of the alternatives was conducted to evaluate their relative performance, and to identify advantages, disadvantages, and key trade-offs that may affect removal action selection.

Recommended Site-Wide Alternative

Based upon the alternative evaluations conducted, the following

conclusions were reached:

- For soils and wastes, landfarming is the preferred alternative, due to its proven track record at other wood-treater sites, and its relatively moderate cost. Construction of a cover was not favored because the contaminated soils and wastes would continue to act as a source of groundwater contamination. LTDD was not favored based on its high cost and the proximity of residences to the site. For the off-site disposal alternative, the cost to dispose of the contaminated soils and wastes off site would be unacceptably high, and therefore, this alternative was not selected;
- For NAPL removal, hot water and steam flushing, which has been used successfully to remove NAPLs at other wood-treater sites, is preferred over surfactant flushing. Surfactant flushing is judged to be unproven, and thus is not recommended for implementation at the JW site; and
- For contaminated groundwater plumes present within the 22nd Street lagoon area and the PCP process area, enhanced in situ bioremediation is the preferred alternative. Based on the high levels of COPCs detected in groundwater during the EE/CA support sampling, the natural attenuation of site contaminants within these two plumes is believed to be progressing too slowly. Ex situ biological treatment, while a feasible alternative, is a more costly and much more labor- and equipment-intensive alternative than in situ treatment. If in situ treatment fails to increase the rate of biodegradation to an acceptable level, ex situ treatment could be implemented in the future. Natural attenuation is recommended, however, for those areas of the site (i.e., Area H and adjacent to the Jennite pit) where groundwater is impacted at much lower concentrations.

Also included in the recommended site-wide removal action are the removal and off-site disposal of listed hazardous wastes, building and silo demolition, and the removal of the miscellaneous items previously mentioned. Removal of the buildings, silos, and miscellaneous items from the site would be necessary in order to implement the removal action to address soils and wastes, NAPLs, and groundwater. If these items are not addressed, contaminated soil above the established CUOs still would be present on site at the completion of the site-wide removal action, and the wastes contained in the various structures would pose a risk of recontaminating soil and groundwater should the structures leak or rupture. Also, removal of these items would facilitate the future redevelopment of this site.

The total estimated cost for implementation of the recommended



site-wide alternative is \$10,510,000.

1

E & E

Ecology and
Environment, Inc.

IEPA

Illinois Environmental
Protection Agency

EE/CA

Engineering Evaluation/
Cost Analysis

CERCLA

Comprehensive
Environmental
Response,
Compensation, and
Liability Act of 1980

SARA

Superfund Amendments
and Reauthorization Act

JW site

Jennison-Wright site

NAPLs

non-aqueous-phase
liquids

NCP

National Oil and
Hazardous Substances
Pollution Contingency
Plan

EPA

United States
Environmental
Protection Agency

ARARs

applicable or relevant
and appropriate
requirements

Introduction

1.1 Introduction

Ecology and Environment, Inc. (E & E), was tasked by the Illinois Environmental Protection Agency (IEPA) to perform an Engineering Evaluation/Cost Analysis (EE/CA) for a non-time-critical removal action under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA, also known as Superfund), as amended by the Superfund Amendments and Reauthorization Act (SARA), at the Jennison-Wright site (JW site), located in Granite City, Madison County, Illinois.

The purpose of this EE/CA is to present the procedures and results of EE/CA support sampling performed at the site by E & E, assess the potential risks posed by site contamination, and identify and evaluate removal action alternatives for contaminated on-site soil, non-aqueous-phase liquids (NAPLs), and groundwater contamination. IEPA has determined that a removal action in accordance with the criteria set forth in Section 300.415(b)(2) of the National Oil and Hazardous Substances Pollution Contingency Plan (the NCP; EPA 1992a) is necessary to reduce the threat posed by these various on-site areas of contamination and waste disposal. An EE/CA is required for all non-time-critical removal actions, pursuant to Section 300.415 (b)(4) of the NCP, to identify, evaluate, and provide a comparative analysis of removal action options for a Superfund hazardous waste site.

This EE/CA has been prepared and organized in accordance with the United States Environmental Protection Agency's (EPA's) *Guidance for Conducting Non-Time-Critical Removal Actions Under CERCLA* (EPA 1993). The remainder of Section 1 presents site background information, including operational history, land use, and a summary of previous investigations and removal actions conducted at the site. EE/CA support sampling procedures and results are presented in Section 2. The results of the Streamlined Risk Evaluation prepared for the JW site are presented in Section 3. The proposed scope and objectives of the removal action and the applicable or relevant and appropriate requirements (ARARs) are discussed in Section 4. Section 5 identifies and describes the

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removal action alternatives developed for the JW site. Section 6 provides individual and comparative alternative evaluations. The recommended removal action alternative for the JW site is presented in Section 7. References cited in this report are listed in Section 8.

1.2 Site Description and Background

1.2.1 Site Location

The JW site is located at 900 West 22nd Street in Granite City, Illinois, approximately 6 miles northeast of downtown St. Louis. The site is approximately 2 miles east of the Mississippi River. More precisely, the site is in Section 13, Township 3N, Range 10W, of Madison County, Illinois. Figure 1-1 shows the site location. Historical aerial photographs of the site are provided in Appendix A.

The site is located in a mixed residential-industrial neighborhood. It is bisected by 22nd Street, with former storage areas for untreated and treated wood located north of the street, and the former facility process areas located south of the street. An Illinois-American Water Company water works facility is located immediately north of the site. Railroad tracks border the site along its entire eastern boundary, and an alley and residences border the site along its entire western boundary.

1.2.2 Site Physical Features

The JW site is a defunct wood-treating facility that processed railroad ties and wood block flooring using creosote, pentachlorophenol (PCP), and zinc naphthenate between the early 1900s and 1989. In addition, a driveway sealer, Jennite, was produced at the facility. A site features map showing the site as it currently exists is presented as Figure 1-2.

PCP
pentachlorophenol

In past investigations, the JW site was divided into 14 areas (Areas A through N). For consistency, this EE/CA will use these previously established area designations. However, several of these "areas" no longer exist (e.g., Area J, an abandoned railcar that has been removed from the site). Areas that no longer exist are not shown on Figure 1-2, and are not discussed here.

Area A consists of the entire northern portion of the JW site (i.e., north of 22nd Street). This area was used for the storage of untreated and treated railroad ties. Area B is a rectangular concrete impoundment that presently holds approximately 3 feet of water. This structure is referred to as the concrete basin in this report. Area C comprises the former PCP process area, and is located in the southern portion of the site. All PCP treatment cylinders and tanks have been removed from the site. Area E is the Jennite pit, which was used for the disposal of process wastes. The pit was



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covered with a geomembrane and clay cover in 1995. Area F consists of the general creosote process area, and is located in the northeast area of the southern portion of the site. Area G is the 22nd Street lagoon. Little is known about this area, other than it was used for the disposal of site wastes. Currently, the area is dry and supports vegetation. Surficial tar deposits and contaminated soil are present in Area H, which is located in the far northeast corner of the site.

USTs
underground storage
tanks

ASTs
aboveground storage
tanks

Also present on site are five buildings (office building, white building, green building, boiler building, and transite building) and two silos; a collapsed pole barn; two empty underground storage tanks (USTs); two aboveground storage tanks (ASTs) which contain oil; several concrete sumps and pits; and debris piles consisting of concrete chunks, scrap metal, wood blocks, and trash.

1.2.3 Site Background

The creosote process was the first wood-preserving process used at the site, and was in operation between the early 1900s and 1989. The creosote process equipment included three treatment cylinders; each was 6 feet in diameter, and lengths varied from 96 feet, to 113 feet, to 136 feet. In addition, there were three 28,000-gallon-capacity creosote working tanks; various steam pumps; a compressor; a vacuum pump; and miscellaneous storage tanks.

The process involved pumping heated creosote (200°F) into a treatment cylinder that was filled with either railroad ties or wood blocks. Heat and pressure were applied to railroad ties for 3 to 4.5 hours. Blocks were heated for approximately one-half hour. The bulk of the creosote was then pumped back to the working tanks. A vacuum was applied to remove the remaining excess creosote, which was then also pumped back to the working tanks (E & E 1985).

At the conclusion of the treatment process, the cylinder door was opened, allowing residual creosote at the bottom of the cylinder to spill out onto the ground. Two in-ground cisterns were located at the rear of the cylinders. These cisterns collected creosote and surface water runoff that had accumulated in the pit. Steam pipes were placed throughout the pit area to heat the spilled creosote and increase the flow of creosote into the cisterns. The contents of the cisterns were then pumped into an aboveground creosote/water separator. Recovered creosote was returned to the working tanks (or a storage tank), and the water was discharged to the municipal sewer system. Creosote was used at an average rate of 805,000 gallons per year, although this quantity fluctuated depending on demand (E & E 1985). As the creosote in a working tank was used, makeup creosote was added from two 160,000-gallon tanks located north of the cylinders. These two tanks were removed

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from the site in 1995.

Wood ties and blocks were transported before and after treatment in small-gauge trams. The rails for the tramway were situated throughout the facility, primarily between the treatment areas on the south side of the site and the storage areas on the north side of the site. Surficial soil contamination resulted from creosote dripping from treated ties and blocks during transportation to storage areas (E & E 1985).

PDC
Peoria Disposal
Company

In 1987, the creosote treating area was retooled and modernized; in the process the old riveted-seam creosote treatment cylinders were removed and replaced with modern welded-seam cylinders. The replacement involved the removal of the cylinders and associated foundations, the cisterns located in the cylinder area, and contaminated soil. In the vicinity of the cisterns, soil was excavated to a depth of several feet below the ground surface. A concrete containment structure (i.e., the concrete basin) was built in the excavation, followed by the installation of the new cylinders. A new tank farm was constructed within the concrete containment structure, and the previously used tanks were demolished. All contaminated soils removed from the excavation were disposed of off site as hazardous waste at the Peoria Disposal Company (PDC) Landfill in Peoria, Illinois (WCC 1988). The replacement of the creosote treating area was performed without IEPA approval. Some visibly contaminated soils remained in the excavation and were covered with concrete.

The PCP process was used from 1960 until 1986 and was located in Area C of the site as shown on Figure 1-2. Decorative wood blocks for flooring were treated with a preservative made up of a light petroleum distillate base and 5% PCP. Process equipment included a 17,000-gallon treatment cylinder, a 15,000-gallon working tank, a storage tank, a compressor, and a vacuum pump. The process involved placing wood blocks carried on trams into the treatment cylinder, which was then filled with the PCP solution. Once the cylinder was full, PCP solution was forced back into the working tank by pressurizing the cylinder. A vacuum was applied to the cylinder for 2.5 hours to draw out excess PCP solution. Air pressure was again applied to clean out the remaining PCP solution. At the conclusion of the treatment process, the cylinder door was opened and the trams were pulled out of the cylinder, allowing the residual PCP solution at the bottom of the cylinder to spill out onto the ground (E & E 1985; WCC 1988).

The PCP treatment cylinder and storage tanks were located on the south side of the site approximately 30 feet from the west boundary of the plant. PCP solution was used at an average rate of 15,000 gallons per year, although this quantity fluctuated depending on

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demand (E & E 1985).

In 1986, the PCP process was replaced with a zinc naphthenate process. The equipment and the area used for the zinc naphthenate process remained unchanged from those used in the PCP process (WCC 1988).

In addition to the wood treatment, Jennite was produced at the site. Jennite was a coal tar pitch product used commercially as a pavement sealant. The basic components were montmorillonite clay, coal tar pitch, and a latex/rubber compound. The product was manufactured at the facility beginning in the early 1960s (E & E 1985).

The Jennite process involved two 35-foot-tall storage silos, assorted mixing chambers, and an emulsion process that utilized three heated tanks. Coal tar pitch and a latex/rubber compound were heated to form an emulsion base. This base was then mixed with the clay to make Jennite, which was then packaged and stored in 55-gallon steel drums (E & E 1985). The Jennite product was also packaged in 5-gallon containers for retail sale. In 1989, the Jennite operations ceased. The two silos still exist on site, and still contain montmorillonite clay.

WCC
Woodward-Clyde
Consultants, Inc.

RIEDEL
RIEDEL Environmental
Services, Inc.

In 1988, Woodward-Clyde Consultants, Inc. (WCC), was retained by the Jennison-Wright Corporation to conduct an environmental assessment of the JW site. This assessment is discussed in Section 1.3.

In 1989, the Jennison-Wright Corporation declared bankruptcy, and wood treatment operations at the site ceased. In 1990, the JW site closed and some of the treatment cylinders, tanks, and rails were salvaged. Between this closure date and 1995, the site was plagued with trespassing, trash disposal, and occasional vandalism. In 1995, the windows and doors of the office building were covered with plywood. This board-up appears to have been successful in reducing trespassing and vandalism. However, people continue to illegally dispose of trash on site by tossing it over the site's fences, especially along the site's west boundary.

In 1991, IEPA completed six soil borings at the site in order to determine the extent of contamination in three off-site areas. This subsurface investigation is discussed in Section 1.4.

In 1992 and 1994-95, RIEDEL Environmental Services, Inc. (RIEDEL), under contract with IEPA, conducted two removal actions at the JW site. These removal actions are discussed in Section 1.5.

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1.2.4 Surface Features and Topography

The JW site is approximately 16.6 acres in size and triangular in shape. The north portion of the site is approximately 9.4 acres, and the south portion of the site is approximately 7.2 acres. The site topography is relatively flat, with the exception of several large debris piles. Surface drainage in areas north of 22nd Street appears to be toward the northeast corner of the site. Surface drainage south of 22nd Street appears to flow to lower-lying on-site areas. After a rain, numerous puddles can be observed across the entire site. A set of topographic base maps for the site is provided in the back pocket of Volume 2 of this report.

Roughly 50% of the site is vegetated with various grasses, weeds, and shrubs. Unvegetated areas of the site include former building locations, former tram areas, former process areas, former tank areas, and debris piles.

1.2.5 Geology and Soils Information

The JW site is located in an area often referred to as the American Bottoms. In the St. Louis metropolitan area, the Mississippi River occupies a deep bedrock valley that has been filled with both glacial outwash material and recent alluvium. The thickness of the valley fill is generally greater than 100 feet. In the Granite City area, the thickness is about 115 feet. The stratigraphy of the valley fill consists of silt, clay, sand, and gravel (Cahokia Alluvium). The upper 15 to 30 feet is commonly silt and clay with fine sand. Below this depth, the deposits vary from poorly graded to well-graded sands and gravels, grading to coarser sands and gravels that extend to bedrock. The bedrock in the area consists of Mississippian and Pennsylvanian limestones and dolomites with lesser amounts of shale and sandstone (Bergstrom and Walker 1956).

BGS
below ground surface

Major supplies of groundwater have historically been withdrawn from the valley fill material. Groundwater in the valley fill deposits occurs under water table (unconfined) conditions. The water table is generally found at depths ranging from 15 to 20 feet below ground surface (BGS). Groundwater flow is primarily south-southwest towards the Mississippi River, except in areas of high pumpage and large depressions in the water table. The bedrock in this area is considered a poor source of water primarily due to its low permeabilities and poor water quality (Bergstrom and Walker 1956).

Approximately 50 water wells have been identified within a 1-mile radius of the JW site. Most of these wells either are used for industrial water supplies or have been installed as monitoring wells for use in groundwater quality investigations. Five domestic wells were identified within the 1-mile radius; however, their locations

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are identified as being upgradient of the JW site (Illinois State Geological Survey 1997; Illinois State Water Survey 1997). According to the Illinois-American Water Company, which distributes potable water for the area, the domestic water supply source for Granite City is the Mississippi River.

At least three industrial wells are located on the adjacent Nestlé Corporation property east of the railroad tracks that border the JW facility. Two of these wells are located on Nestlé's western property line. One well formerly was used to supplement Nestlé's sprinkler system. The other was used as process water in a non-contact capacity. A third well is located on the eastern side of the Nestlé property and was used only when the process water well was out of service. All of these wells are 113 to 117 feet deep and have 30- to 35-foot screens (WCC 1988). Based on a telephone conversation with Nestlé personnel, these wells were taken out of service in January 1997, and have not been used since. Any future pumping from these wells would occur only as a backup for the Nestlé plant's sprinkler system in the case of a fire (Graczyk 1997).

1.2.6 Surrounding Land Use and Population

Land use around the JW site is a residential and industrial mix. Private dwellings are located adjacent to the site along the west and northwest boundaries. To the northeast, the site borders an Illinois-American Water Company water works facility. This utility supplies potable water to numerous communities, including Granite City and East St. Louis. Railroad tracks form the east boundary of the site. During EE/CA support sampling, it was noted that Norfolk Southern locomotives used these tracks. Across the tracks to the east is an industrial area, including the Nestlé facility previously mentioned, and an Illinois Power Company facility.

1.2.7 Meteorology

Granite City, Illinois, is located near the confluence of the Missouri and Mississippi rivers, close to the geographical center of the United States. The area has a modified continental climate, demonstrated by the changes of a four-season climate without prolonged periods of extreme cold or hot weather. To the south is the warm, moist air of the Gulf of Mexico, and to the north, in Canada, is a region of cold air masses. The alternate invasions by air masses from these sources, and the conflict along the frontal zones where they come together, produce a variety of weather conditions (Ruffner and Blair 1985).

Winters are brisk and last for long periods, but are seldom severe. Records since 1870 show that temperatures drop to 0 degrees Fahrenheit (°F) or below on an average of two to three days per year. Temperatures remain as cold as 32 °F or lower for fewer

°F
degrees Fahrenheit

VOCs
volatile organic
compounds

SVOCs
semivolatile organic
compounds

PCBs
polychlorinated
biphenyls

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than 25 days in most years. Table 1-1 shows the average maximum and minimum daily temperature and precipitation for the area. Snowfall has averaged a little over 18 inches per winter season. Snowfall of an inch or more is received on five to 10 days in most years (Ruffner and Blair 1985).

The long-term record for St. Louis indicates that temperatures of 90 °F or higher occur on about 35 to 40 days a year. Extremely hot days of 100 degrees or more are expected on no more than five days per year.

Normal annual precipitation for the area is slightly less than 34 inches. The three winter months are the driest, with an average total of about 6 inches of precipitation. The spring months of March through May are normally the wettest, with normal total precipitation of just under 10.5 inches. It is not unusual to have extended dry periods of one to two weeks during the growing season (Ruffner and Blair 1985).

1.3 1988 Woodward-Clyde Site Assessment

In 1988, WCC completed a site assessment as part of a Judicial Consent Decree signed between the Jennison-Wright Corporation and the State of Illinois on January 15, 1986. The site assessment consisted of collecting and chemically analyzing soil samples from four off-site background locations and 29 on-site soil borings drilled to the water table (approximately 17 feet BGS).

Groundwater samples were collected and chemically analyzed from 16 monitoring wells, of which 11 were shallow wells (screened at the water table), one was an intermediate well (screened at approximately 60 feet BGS), and four were deep wells (installed to the bedrock surface at depths ranging from 113 to 117 feet BGS). Soil and groundwater samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides/polychlorinated biphenyls (PCBs), and metals. Also, selected soil and groundwater samples were analyzed for dioxins and furans (WCC 1988).

*11 shallow wells
1 intermediate
4 deep wells*

µg/kg
micrograms per kilogram

1,1,1-TCA
1,1,1-trichloroethane

1,1-DCE
1,1-dichloroethene

µg/L
micrograms per liter

OVA
organic vapor analyzer

The results of the WCC site assessment indicated that soil conditions underlying the site consist of seams of clayey and sandy soils within the upper 25 feet. Sandy and gravelly soils were encountered below 25 feet and extended to bedrock. Groundwater was encountered at a depth of approximately 17 feet BGS, and was found to flow in a southwesterly direction across the site (WCC 1988).

Subsurface contamination was found by WCC in both soil and groundwater at the JW site. Soil contamination was noted both visually and analytically through the unsaturated zone to groundwater, in the vicinity of the 22nd Street lagoon, the Jennite



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pit, and the PCP treatment area. All of these areas are located south of 22nd Street. Soil contamination in the remainder of the site was found to depths ranging from less than 1 foot to 5 feet BGS. Soil contaminants at the site consisted primarily of the following compounds (maximum concentration detected): ethylbenzene (84,000 micrograms per kilogram [$\mu\text{g/kg}$]); 1,1,1-trichloroethane (1,1,1-TCA) (860 $\mu\text{g/kg}$); total xylenes (210,000 $\mu\text{g/kg}$); toluene (49,000 $\mu\text{g/kg}$); benzene (8,900 $\mu\text{g/kg}$); styrene (5,300 $\mu\text{g/kg}$); naphthalene (4,200,000 $\mu\text{g/kg}$); phenanthrene (2,800,000 $\mu\text{g/kg}$); 2-methylnaphthalene (780,000 $\mu\text{g/kg}$); fluoranthene (1,500,000 $\mu\text{g/kg}$); pyrene (1,200,000 $\mu\text{g/kg}$); anthracene (1,600,000 $\mu\text{g/kg}$); fluorene (930,000 $\mu\text{g/kg}$); and PCP (670,000 $\mu\text{g/kg}$).

Groundwater contamination in the shallow monitoring wells was found to be localized in the three previously mentioned areas where soil contamination extended to groundwater. Contaminants found in groundwater included (maximum concentration detected): 1,1-dichloroethene (1,1-DCE) (11 micrograms per liter [$\mu\text{g/L}$]); benzene (1,200 $\mu\text{g/L}$); ethylbenzene (72 $\mu\text{g/L}$); styrene (40 $\mu\text{g/L}$); toluene (880 $\mu\text{g/L}$); total xylenes (216 $\mu\text{g/L}$); phenol (9,800 $\mu\text{g/L}$); naphthalene (5,500 $\mu\text{g/L}$); 2-methylnaphthalene (260 $\mu\text{g/L}$); acenaphthene (190 $\mu\text{g/L}$); fluorene (85 $\mu\text{g/L}$); phenanthrene (110 $\mu\text{g/L}$); pyrene (15 $\mu\text{g/L}$); and PCP (100 $\mu\text{g/L}$). Groundwater contamination was not found in the one intermediate or the four deep wells at the site (WCC 1988).

1.4 1991 IEPA Subsurface Investigation

In 1991, IEPA completed six soil borings at the JW site in order to determine the horizontal and vertical extent of contamination in three off-site areas. Two borings were completed in each area of concern: Area H (located in the northeast corner of the site), the 22nd Street lagoon (Area G), and the Jennite Pit (Area E). Each boring was sampled at a continuous interval and advanced to, or just below, the water table. Soils were logged by a geologist, and each sample interval was screened for organic vapors using an organic vapor analyzer (OVA). No soil samples were submitted to a laboratory for chemical analysis.

Soil samples from all six borings showed visible signs of contamination, as well as discolored, oily groundwater contamination. Borings completed in Area H and the 22nd Street lagoon exhibited gross soil contamination throughout the entire boring length, with OVA readings between 100 and greater than 1,000 meter units. For the borings completed at the Jennite Pit, visible surface contamination appeared to improve at depths of 4 to 6 feet. No OVA readings were observed until just below the water table, where soils exhibited readings greater than 1,000 meter units (IEPA 1991).

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1.5 Previous Removal Actions

Under contract with IEPA, RIEDEL, of Chesterfield, Missouri, performed two removal actions at the JW site. Each of these removal actions is discussed below.

1.5.1 1992 Removal Action

In May 1992, RIEDEL and its asbestos removal subcontractor, Environmental Operations, Inc. (EO), performed a removal action under the direction of IEPA at the site. During this effort, the following work was accomplished:

EO
Environmental
Operations, Inc.

ACM
asbestos-containing
material

HDPE
high-density
polyethylene

- 22 cubic yards of asbestos-containing material (ACM) were removed from several piles on site, and transported to the Litchfield/Hillsboro Landfill in Montgomery County, Illinois, for disposal;
- An additional fifteen 55-gallon drums of ACM contaminated with creosote were moved into the transite building;
- One hundred twenty-one 55-gallon drums of unknown contents that were located throughout the site were moved to the transite building;
- 1,300 gallons of creosote-contaminated water was pumped to the west 160,000-gallon aboveground storage tank;
- Creosote, tar, and contaminated soil that had migrated off site from the Jennite pit along the site's eastern fenceline was excavated and placed into three cutoff tanks located east of the green building for temporary storage; and
- The three cutoff tanks were covered with wooden lids and high-density polyethylene (HDPE) geomembrane liners (RIEDEL 1992).

RIEDEL and EO completed the above work on May 28, 1992. A final report of the removal action was prepared by RIEDEL and submitted to IEPA (RIEDEL 1992).

1.5.2 1994-95 Removal Action

RIEDEL, under contract with IEPA, mobilized a crew on November 8, 1994, to begin a second removal action at the JW site. This removal implemented the action recommended in the first EE/CA report that was prepared for this site (E & E 1994). The objective of the 1994 EE/CA report was to focus on the most significant sources of contamination present on site (i.e., drums and tanks). After completion of the 1994 EE/CA report, a public meeting was held to discuss the recommendations made in the

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report, an Action Memorandum was prepared to address public comments, and technical specifications were prepared by E & E for the removal action.

During this removal action, RIEDEL performed the following work:

- A 100-foot by 150-foot crushed stone support zone area was constructed just inside of the fence on the south side of 22nd Street and west of the JW office building;
- The two 160,000-gallon aboveground tanks located south of 22nd Street and east of the JW office building were dismantled, cleaned, and scrapped. Five hundred and three cubic yards of sludge from these tanks was solidified and disposed of off site at the Chemical Waste Management of Indiana, Inc. facility located in Fort Wayne, Indiana;
- An aboveground railcar located north of 22nd Street was dismantled, cleaned, and disposed of;
- A buried railcar located south of 22nd Street and west of the 22nd Street lagoon was excavated, dismantled, cleaned, and disposed of;
- The three cutoff tanks located in the former creosote process area were emptied, dismantled, cleaned, and disposed of. A large amount of sludge from these tanks was solidified and disposed of off site at the Chemical Waste Management of Indiana, Inc. facility located in Fort Wayne, Indiana;
- A total of 49,530 gallons of water removed from the above-mentioned tanks and railcars was treated on site and discharged to the Granite City sanitary sewer system;
- A total of 183 drums of soil was solidified and disposed of off site;
- Chain-link fencing 450 feet long was installed around Area H, located in the far northeast corner of the site;
- An engineered cap consisting of a 40-mil HDPE liner and a vegetated cap was constructed over the Jennite pit (Area E); and
- Miscellaneous debris collected from across the site was stockpiled along the east property fence line to the north of the transite building (RIEDEL 1995).



1. Introduction

RIEDEL demobilized from the site during the week of March 6, 1995. A final report of the removal action was prepared by RIEDEL and submitted to IEPA (RIEDEL 1995). The removal action was performed under IEPA supervision.

Table 1-1

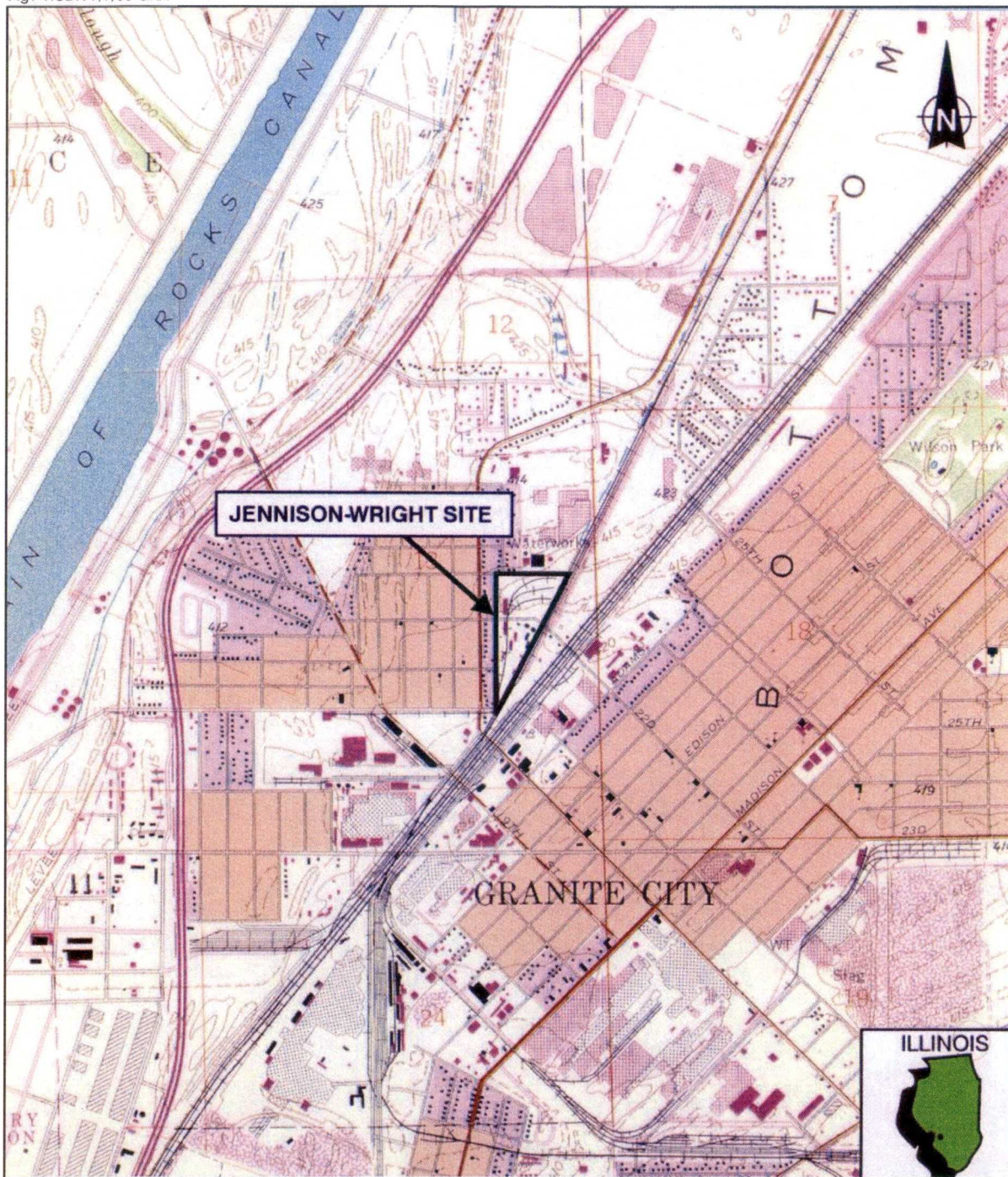
**WEATHER DATA
NORMALS, MEANS, AND EXTREMES
ST. LOUIS, MISSOURI**

Parameter	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Temperature, °F:													
Normals													
- Daily Maximum	37.6	43.1	53.4	67.1	76.4	85.2	89.0	87.4	80.7	69.1	54.0	42.6	65.5
- Daily Minimum	19.9	24.5	33.0	45.1	54.7	64.3	68.8	66.6	58.6	46.7	35.1	25.7	45.3
- Monthly	28.8	33.8	43.2	56.1	65.6	74.8	78.9	77.0	69.7	57.9	44.5	34.2	55.4
Precipitation, inches:													
Water Equivalent													
- Normal	1.72	2.14	3.28	3.55	3.54	3.73	3.63	2.55	2.70	2.32	2.53	2.22	33.91
- Maximum Monthly	5.38	4.17	6.67	9.09	7.25	9.43	10.71	6.44	8.88	7.12	9.95	7.82	10.71
- Minimum Monthly	0.22	0.25	1.09	0.99	1.02	0.47	0.60	0.08	T	0.21	0.44	0.32	T

Key:

T = Trace.

Source: Ruffner and Blair 1985.



SOURCE: USGS 7.5 Minute Series (Topographic) Quadrangle: Granite City, ILL.-MO., 1954
photorevised 1993.

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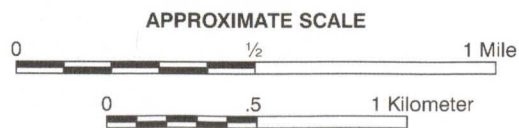
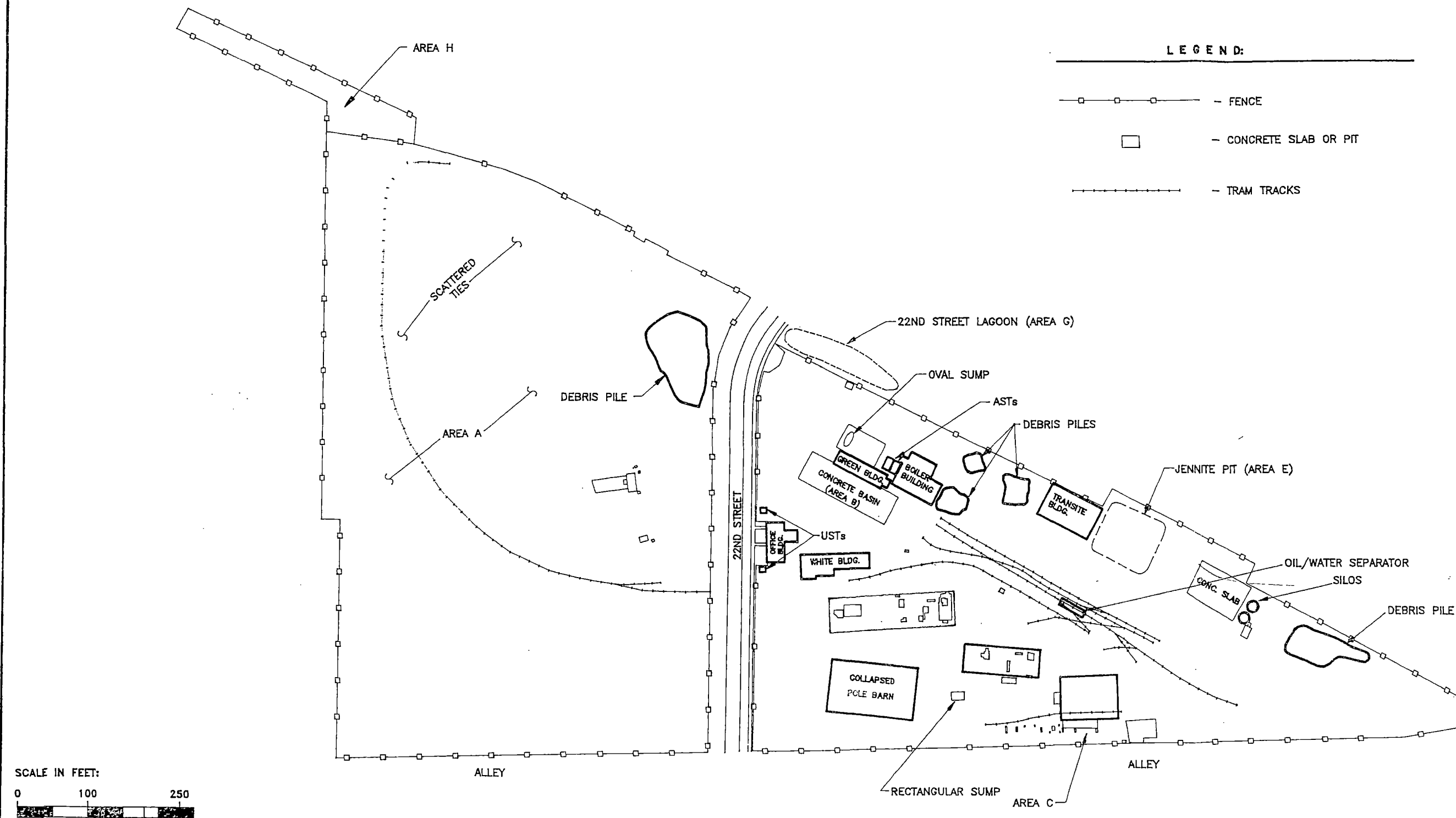


Figure 1-1 SITE LOCATION MAP



ecology and environment

FIGURE 1-2 SITE FEATURES MAP
JENNISON-WRIGHT SITE
GRANITE CITY, ILLINOIS

2

EE/CA Support Sampling

FSP
Field Sampling Plan

QAPP
Quality Assurance
Project Plan

From July through September 1997, and in December 1997, E & E conducted EE/CA support sampling at the JW site to obtain data to support the preparation of this EE/CA report. The investigation included a site reconnaissance, a site survey, surface and subsurface soil sampling, a bench-scale biofeasibility study and a structures investigation, that encompassed a structural assessment of the existing site buildings, sediment sampling, and sampling of suspect ACM. A hydrogeologic investigation also was conducted, which included groundwater sampling with a Geoprobe; the installation, development, and sampling of new monitoring wells; the redevelopment and sampling of existing site monitoring wells; and aquifer testing. A summary of the sampling activities conducted and the procedures followed by E & E during the EE/CA support sampling are described in Section 2.1. All field investigation activities were performed in accordance with the procedures specified in the EE/CA Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP) (E & E 1997). The results of the field investigation are presented in Section 2.2.

2.1 EE/CA Support Sampling Procedures

2.1.1 Site Reconnaissance

A site reconnaissance was conducted by E & E and IEPA on April 29, 1997, to evaluate the existing site conditions, including the status of the site monitoring wells installed by WCC in 1988, the integrity of the site structures, and the feasibility of using a Geoprobe for sampling activities.

During the site reconnaissance, 11 existing monitoring wells (MW1S, MW1D, MW2S, MW3S, MW3D, MW4S, MW5S, MW6M, MW6D, MW10S, and MW11S) were determined to be suitable for redevelopment and sampling; the remaining five wells installed by WCC were either damaged (MW6S) or could not be located (MW7S, MW8S, MW9S, and MW9D). Well MW6S was subsequently repaired and well MW7S was located during the EE/CA support sampling. A NAPL layer, about 1-inch thick, was measured in the bottom of monitoring well MW5S.

At the time of the initial inspection, the site buildings were observed

2. EE/CA Support Sampling

to be in poor condition, requiring a comprehensive inspection by a professional structural engineer. In addition, suspected ACM was observed in the buildings, and sediments were observed in a concrete lagoon and various sumps and pits present on the site. Therefore, these media were proposed for sampling during the field investigation.

The IEPA Geoprobe was used to advance two soil borings. One boring was placed in an area covered with tar and asphalt; the other boring was placed in a very loose sand. Both borings were completed with little difficulty, and good sample recovery was observed. Consequently, the use of the Geoprobe for sampling activities during the field investigation was confirmed.

USGS
U.S. Geological Survey

2.1.2 Site Survey

E & E subcontracted a registered land surveyor, Zambrana Engineering, Inc., of St. Louis, Missouri, to establish a 100-foot by 100-foot grid system across the site for sampling purposes during the surface soil sampling effort, and for the identification of other soil and groundwater sample collection points. The survey activities also included the preparation of a set of topographic base maps of the site (1-foot contour interval) and the identification of all significant site and adjacent off-site features (i.e., buildings, tanks, fencing, roads, waste piles, railroad tracks). All new and existing monitoring well locations were surveyed to a horizontal accuracy of 1.0 foot; and all top-of-inner-monitoring-well casing elevations were surveyed to an accuracy of 0.01 foot. Horizontal and vertical controls were tied into the Illinois State Plane coordinate system and a U.S. Geological Survey (USGS) benchmark datum, respectively. The set of topographic maps (nine sheets) is provided in the back pocket of Volume 2 of this EE/CA report.

2.1.3 Surface Soil Sampling

The objectives of the surface soil sampling were to evaluate the extent of surficial contamination and to provide the data needed to evaluate the potential risks to human health and the environment in the SRE. A total of 81 gridded surface soil samples, four off-site background surface soil samples, and 11 biased surface soil samples were collected. Most of the surface soil samples were collected from the 0- to 6-inch depth interval; at six grid node locations, only a 0- to 3-inch depth interval was sampled due to the presence of gravel or subsurface obstructions. All samples were collected using a shovel or hand trowel. With the exception of the off-site samples, the surface soil sampling locations are shown on Figure 2-1. Off-site samples SS100 and SS101 were collected in Barry Loman Park located on Rock Road near Illinois Route 3; and off-site samples SS102 and SS103 were collected in Triangle Park located at the

2. EE/CA Support Sampling

intersection of 21st Street and Rock Road. A summary of the surface soil samples collected and the chemical analyses performed is presented in Table 2-1. The analytical results are discussed in Section 2.2.

PAHs

polynuclear aromatic hydrocarbons

ASC

Analytical Services Center

HPLC

high-performance liquid chromatography

TCL

Target Compound List

TAL

Target Analyte List

CLP

Contract Laboratory Program

TCLP

toxicity characteristic leaching procedure

Btu

British thermal unit

Grid Samples. Eighty-one surface soil samples (SS01 through SS84 [SS09, SS31, and SS54 were not taken]) were collected at node locations defined by the sampling grid. All gridded surface soil samples were analyzed for polynuclear aromatic hydrocarbons (PAHs) at E & E's Analytical Services Center (ASC) using a single-column high-performance liquid chromatography (HPLC) screening procedure, modified from EPA Method 8310, and also screened at the on-site field laboratory for PCP using immunoassay techniques (EPA Method 4010). Sixteen samples (SS05, SS10, SS15, SS20, SS25, SS30, SS35, SS39, SS45, SS50, SS55, SS60, SS65, SS70, SS75, and SS80) were also analyzed for Target Compound List (TCL) VOCs, SVOCs, pesticides/PCBs, and Target Analyte List (TAL) inorganics at an EPA Contract Laboratory Program (CLP) laboratory. Surface soil samples SS09 and SS54 were not collected because their grid node locations fell just outside of the site's boundaries, and a debris pile at sample location SS31 also precluded collection of a surface soil sample at this grid node.

Biased Samples. Eleven surface soil samples (SS85 through SS96) were collected from biased locations not defined by the grid system. These sample locations targeted known disposal areas (SS85, SS86, SS87, SS91, SS92, and SS96), suspected spill areas (SS94 and SS95), and areas of visual surficial contamination (SS88, SS89, and SS90). All biased surface soil samples were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL inorganics, and dioxins/furans at an EPA CLP laboratory. In order to evaluate the potential treatability of site soils and to determine if they would be characteristic hazardous waste, one sample (SS89) was also analyzed for toxicity characteristic leaching procedure (TCLP) organics and inorganics, flash point, paint filter test, ash, British thermal unit (Btu) content, and reactivity (disposal parameters). Because of the presence of a sump adjacent to surface soil sample location SS93, a sediment sample (SD04) was collected in lieu of a surface soil sample at this location (see Section 2.1.6.2 for sediment sampling information).

2.1.4 Soil Boring and Subsurface Soil Sampling Investigation

A total of 58 Geoprobe subsurface soil samples and 14 drill rig subsurface soil samples were collected at the site. The Geoprobe operation and sample collection activities were conducted by IEPA personnel. E & E subcontracted Layne-Western, Inc. of Fenton, Missouri, to perform the drilling activities during the EE/CA

2. EE/CA Support Sampling

support sampling. The objectives of the subsurface soil sampling were to evaluate the nature and extent of subsurface contamination, to refine the knowledge of site stratigraphy, and to provide additional data needed in the SRE to evaluate the potential risks to human health and the environment during potential future site activities. The soil boring locations are shown on Figure 2-2; a summary of the subsurface soil samples collected and the chemical analyses performed is presented in Table 2-1. The analytical results are discussed in Section 2.2.

SOP
standard operating
procedure

OD
outside diameter

PID
photoionization detector

CME
Central Mine Equipment

HSAs
hollow-stem augers

Geoprobe Subsurface Soil Samples. A total of 58 subsurface soil samples were collected from 29 soil borings (SB01 through SB30) advanced with a Geoprobe. The Geoprobe soil boring locations are shown on Figure 2-2. The Geoprobe was operated in accordance with IEPA's standard operating procedure (SOP). Subsurface soil samples were collected at a continuous sample interval with a 2-inch outside diameter (OD) Macro-Core sampler. Each sample was field-screened for organic vapors using an HNu photoionization detector (PID), and stratigraphy was logged by E & E's field geologist (see Appendix B for boring logs). After the soil boring and sampling activities, bentonite chips were backfilled into each borehole.

Two subsurface soil samples were collected from each Geoprobe soil boring, at approximately 6 and 12 feet BGS. All samples were submitted to E & E's ASC for single-column HPLC PAH screening, and were also screened at the on-site field laboratory for PCP. Twelve samples from soil borings SB04, SB07, SB08, SB12, SB14, SB17, SB18, SB19, SB20, SB23, SB25, and SB29 were also analyzed for TCL VOCs, SVOCs, pesticides/PCBs, and TAL inorganics at an EPA CLP laboratory. Based on the presence of subsurface soil contamination at locations in the vicinity of proposed soil boring SB10, this soil boring was omitted from the field investigation.

Drill Rig Subsurface Soil Samples. A total of 14 subsurface soil samples were collected from four soil borings (SB31 through SB34) and two of the monitoring well borings (MW8S and MW9S) advanced with the drill rig. The drill rig soil boring locations are shown on Figure 2-2. A Central Mine Equipment (CME)-75 truck-mounted drill rig equipped with 4.25-inch hollow-stem augers (HSAs) was used to advance the six borings.

Subsurface soil samples at soil borings SB31 through SB34 were collected at a continuous sample interval using a 5-foot-long CME sampler until the water table was encountered. In order to sample soils beneath the concrete basin and the Jennite pit, soil borings SB33 and SB34 were advanced at angles of 30° and 35° from

2. EE/CA Support Sampling

vertical, respectively. Each sample was field-screened for organic vapors using a PID, and stratigraphy was logged by E & E's field geologist (see Appendix B for boring logs). Following the soil boring activities, cuttings were backfilled into each borehole and topped with approximately 3 feet of bentonite chips. The bentonite chips were hydrated. Any remaining cuttings were spread in a thin layer adjacent to each boring.

MIL
Microbe Inotech
Laboratories, Inc.

Subsurface soil samples were selected for analysis were based on visual evidence of contamination and elevated PID readings at soil borings SB32 and SB33. Neither of these conditions was encountered at SB31 or SB34; consequently, a subsurface soil sample from the base of the unsaturated zone was selected for analysis. Samples SB31 (12-13), SB32 (8-10), SB33 (6-8), and SB34 (16-17) were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, and TAL inorganics at an EPA CLP laboratory. (Note that the interval from which the sample was collected is specified in parentheses following the sample number.) Sample SB32 (8-10) was also analyzed for TCLP organics and inorganics, flash point, paint filter test, Btu content, and reactivity. An additional sample interval was collected from soil borings SB32 (6-7) and SB33 (12-13) and submitted to Microbe Inotech Laboratories, Inc. (MiL) of St. Louis, Missouri, to be used in a bench-scale biofeasibility study. The objectives of the biofeasibility study were to identify bacterial strains present in on-site soil and groundwater, and determine the potential effectiveness and feasibility of bioremediation for the site. Further discussion of the biofeasibility study is provided in Section 2.3.

Subsurface soil samples at monitoring well boring MW8S were collected at a continuous sample interval using a 5-foot-long CME sampler above the water table, and a 2-foot-long, 2-inch-OD split-spoon sampler below the water table. Subsurface soil samples at monitoring well boring MW9S were collected at 5-foot sample intervals using a 2-foot-long, 2-inch-OD split-spoon sampler. The 5-foot sample interval was chosen in order to collect samples for analysis only (the stratigraphy was previously logged at adjacent soil boring SB34). Each sample was field-screened for organic vapors using a PID, and stratigraphy was logged by an E & E field geologist (see Appendix B for boring logs). Following the soil boring activities, a monitoring well was installed at each location (refer to Section 2.1.5 for the hydrogeologic investigation details). Soil cuttings were spread in a thin layer adjacent to each boring.

Subsurface soil samples for analysis were collected at the 5-, 10-, 15-, and 20-foot depth interval from each of the two monitoring well borings. All samples were analyzed for TCL SVOCs at an EPA CLP laboratory. Samples MW8S-10 and MW9S-10 were

2. EE/CA Support Sampling

also submitted for pH analysis; and samples MW8S-20 and MW9S-20 were also submitted for total organic carbon (TOC) and grain size analysis.

TOC
total organic carbon

L/min
liters per minute

°C
degree Celsius

NTUs
nephelometric turbidity
units

2.1.5 Hydrogeologic Investigation

The hydrogeologic investigation at the JW site included Geoprobe groundwater sampling and field-screening analysis; the installation, development, and sampling of new monitoring wells; the redevelopment and sampling of existing site monitoring wells; and aquifer testing. The objectives of the hydrogeologic investigation were to refine the understanding of the site stratigraphy and groundwater flow regime, to further characterize the groundwater quality, and to determine the approximate horizontal and vertical boundaries of any contaminant plumes. The Geoprobe groundwater screening locations and monitoring well locations are shown on Figures 2-3 and 2-4, respectively. A summary of the groundwater samples collected and the chemical analyses performed is presented in Table 2-1. The analytical and physical results are discussed in Section 2.2.

2.1.5.1 Geoprobe Groundwater Samples

A total of 37 Geoprobe groundwater screening samples were collected at 30 Geoprobe groundwater screening locations (GP01 through GP20 and GP32 through GP42); the screening locations are provided on Figure 2-3. The objectives of the Geoprobe groundwater screening efforts were to determine the approximate horizontal and vertical extent of groundwater contamination, and to determine the optimum locations for the placement of new monitoring wells. A summary of the Geoprobe groundwater screening samples collected and the chemical analysis performed is presented in Table 2-1. The analytical results are discussed in Section 2.2.

The on-site Geoprobe operation and sample collection activities were conducted by IEPA personnel in accordance with IEPA's SOP. A 1-inch-OD slotted rod assembly was advanced to approximately 24 feet BGS for shallow groundwater sample collection and/or to approximately 40 feet BGS for intermediate groundwater sample collection. A peristaltic pump with disposable tubing was used for purging and sampling at each screening location. Groundwater was purged at a rate of approximately 0.5 liters per minute (L/min) and monitored for stabilization of temperature (± 1 degree Celsius [$^{\circ}\text{C}$]), specific conductance ($\pm 10\%$), pH (± 0.2), turbidity (less than 10 nephelometric turbidity units [NTUs] or $\pm 20\%$), and dissolved oxygen ($\pm 10\%$). Upon stabilization of these parameters, the pumping rate was decreased to less than 0.5 L/min, and a groundwater sample was collected. After Geoprobe groundwater screening activities, bentonite chips

2. EE/CA Support Sampling

were backfilled into the borehole. All samples were submitted to E & E's ASC for single-column HPLC PAH screening. During July and August 1997, samples from locations GP01 through GP20 were analyzed at the on-site field laboratory using an immunoassay screening method for PCP (EPA Method 4010). During September and December 1997, samples from locations GP32 through GP42 were submitted to E & E's ASC for PCP analysis (EPA Method 8270). Four samples from screening locations GP07, GP08, GP12, and GP18 were also analyzed for TCL VOCs, SVOCs, pesticides/PCBs, and TAL inorganics at an EPA CLP laboratory. Because of difficulties in maintaining a sufficient head in the intermediate portion of the aquifer at screening location GP15, no intermediate sample was collected. Based on the presence of groundwater contamination at locations upgradient and downgradient of GP10, this groundwater screening sample location was omitted from the field investigation. Geoprobe screening sample location hole GP38 was subsequently installed in the planned vicinity of GP10.

Based on the presence of groundwater contaminants along the western property boundary, additional groundwater screening sampling was conducted in September 1997 using E & E's Geoprobe. All sampling procedures followed those described above. Intermediate groundwater samples were collected at one on-site location (GP32) and three off-site locations (GP33, GP34, and GP35). All samples were submitted to E & E's ASC for PCP and PAH screening analysis.

Following review of the initial groundwater screening analytical data and data from the monitoring well sampling, E & E and IEPA returned to the site in December 1997 to conduct additional Geoprobe groundwater screening sampling. This sampling was conducted to provide better definition of the vertical and horizontal extent of groundwater contamination downgradient of confirmed source areas. During the December 1997 work, a total of five shallow (GP36S, GP37S, GP38S, GP41S, and GP42S) and five intermediate (GP36M, GP37M, GP38M, GP39M, and GP40M) groundwater samples were collected and submitted to E & E's ASC for PCP and PAH screening analysis.

2.1.5.2 Monitoring Well Installation and Development

E & E subcontracted Layne-Western, Inc. of Fenton, Missouri, to perform the monitoring well drilling, installation, and development activities during the EE/CA field investigation. The primary objectives of the monitoring well installations were to monitor the groundwater quality within the shallow, intermediate, and deep portions of the aquifer, and to provide groundwater elevation data to evaluate the hydrogeologic conditions at the site. A total of

2. EE/CA Support Sampling

eight new monitoring wells were installed at the site. One well nest, consisting of a shallow, intermediate, and deep well (MW8S, MW8M, and MW8D) was installed in the former PCP process area; and a second well nest (MW9S, MW9M, and MW9D) was installed downgradient of the Jennite pit. Based on the results of the Geoprobe groundwater screening sampling, a deep well (MW5D) was nested with the existing shallow well MW5S, and an intermediate well (MW11M) was nested with the existing shallow well MW11S. Upon further inspection of the damaged shallow well MW6S, EPA and E & E elected to repair this well by removing the above-grade portion of the well and converting it into a flush-mount, in lieu of installing a replacement well. Also, well MW7S, a flush-mount, was found beneath a layer of gravel, so a new shallow well was not installed in this area. New and existing monitoring well locations are shown on Figure 2-4.

IR
Ingersoll-Rand

PDC
Peoria Disposal
Company

ID
inside diameter

Shallow monitoring well borings were advanced with a CME-75 truck-mounted drill rig equipped with 4.25-inch ID HSAs. Subsurface soil samples were collected using either a 5-foot-long CME sampler or a 2-foot-long, 2-inch-OD split-spoon sampler (refer to Section 2.1.4 for subsurface sampling information). Intermediate and deep monitoring well borings were advanced with an Ingersoll-Rand (IR)-TH60 air rotary drill rig using dual-tube reverse circulation drilling techniques. No samples were collected for analysis from the intermediate and deep borings; however, the stratigraphy was logged by E & E's field geologist. With the exception of MW5D, all cuttings were spread in a thin layer adjacent to each monitoring well; cuttings from the drilling of MW5D appear to contain NAPL, and were containerized in 55-gallon drums and staged on site. The drums were transported to Peoria Disposal Company (PDC) for disposal on January 30, 1998.

All new monitoring wells were constructed of 2-inch inside diameter (ID), Type 304 stainless steel riser pipe and screen with flush-threaded joints. The well screens are 10 feet long with 0.010-inch slots of continuous wire-wound design. Shallow monitoring wells MW8S and MW9S were installed at 25 and 24.5 feet BGS, respectively, in order to intersect the water table. Intermediate monitoring wells MW8M, MW9M, and MW11M were installed at 52.5, 55, and 55.5 feet BGS, respectively; and deep monitoring wells MW8D, MW9D, and MW5D were installed at 110.5, 117, and 115 feet BGS, respectively, in order to monitor groundwater at or near the bedrock surface. A filter pack consisting of washed 20/40 sieved silica sand was placed in the annular space surrounding the well screen, and extended to a minimum of 2 feet above the top of the screen. Because of flowing sands encountered in the intermediate portion of the aquifer, the annular space surrounding the screen at monitoring wells MW8M, MW9M, and

2. EE/CA Support Sampling

MW11M consists of a mixture of silica sand pack and native sands. A high-percentage solids bentonite grout was tremie-placed from the top of the filter pack to within 3 feet of ground surface. A 5-foot-long protective steel casing with a locking cap was placed over each well and cemented in place to provide well security (see Appendix C for monitoring well boring and construction diagrams).

All new and existing monitoring wells were developed using air-lift methods. Development was completed upon extraction of a minimum of five well volumes and/or stabilization of temperature, specific conductance, pH, turbidity, and dissolved oxygen (refer to Section 2.1.5.1 for stabilization requirements). With the exception of monitoring wells MW5S and MW5D, all development and redevelopment water was discharged to the ground surface in the vicinity of the well; water extracted from wells MW5S and MW5D was visibly contaminated, and thus was containerized in 55-gallon drums and staged on site. The drums were transported to PDC for disposal on January 30, 1998.

TOIC
top of the inside casing

Elevations of the top of the inside casing (TOIC) of the new and existing monitoring wells were surveyed to an accuracy of 0.01 feet; these elevations were tied into a USGS benchmark datum. The TOIC elevations were used to convert depth to water measurements at each well into groundwater elevations in order to determine groundwater flow direction and hydraulic gradients at the site. A summary of the groundwater elevation data for the site is provided in Tables 2-2 and 2-3; the groundwater data are discussed in Section 2.2.

2.1.5.3 Groundwater Monitoring and Sampling

A total of 24 groundwater samples were collected at the eight new and 16 existing monitoring wells. Further inspections conducted during the field investigation activities revealed the presence of existing monitoring well MW7S, as previously mentioned, as well as three existing off-site monitoring wells (referred to as old 8S, old 8D, and old 10D). Monitoring well locations are shown on Figure 2-4. A summary of the monitoring well groundwater samples collected and the chemical analyses performed is presented in Table 2-1. The analytical results are discussed in Section 2.2.

All groundwater monitoring and sampling activities were conducted in accordance with the procedures specified in the EE/CA FSP and QAPP (E & E 1997). Water level measurements were collected on September 5, 1997, prior to groundwater sampling, which was conducted from September 8 to September 15, 1997. A second round of water level measurements was collected on December 11, 1997. Depth to water and depth of well measurements were made

8 new wells
16 existing wells

2. EE/CA Support Sampling

in order to calculate purge volumes prior to groundwater sample collection. A peristaltic pump with disposable tubing was used for purging and sampling at each monitoring well. Groundwater was purged at a rate of approximately 0.5 L/min and monitored for stabilization of temperature, specific conductance, pH, turbidity, and dissolved oxygen (refer to Section 2.1.5.1. for stabilization requirements). Upon stabilization of these parameters, the pumping rate was decreased to less than 0.5 L/min, and a groundwater sample was collected.

TSS
total suspended solids

TDS
total dissolved solids

BOD
biochemical oxygen
demand

COD
chemical oxygen
demand

All on-site monitoring well groundwater samples were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, and TAL inorganics at an EPA CLP laboratory. The sample from monitoring well MW5S was also analyzed for total suspended solids (TSS), total dissolved solids (TDS), biochemical oxygen demand (BOD), and chemical oxygen demand (COD). The sample from well MW8S was analyzed for these same parameters with the exception of COD. Samples from monitoring wells MW5S and MW10S were also submitted to the MiL for use in the biofeasibility study. Further discussion of the biofeasibility study is provided in Section 2.3. Based on the age and construction of the existing off-site monitoring wells, old 8S, old 8D, and old 10D, limited purging was conducted prior to sampling with no monitoring of field parameters. Groundwater samples from these monitoring wells were submitted to E & E's ASC for PCP and PAH screening analysis only.

2.1.5.4 Aquifer Testing

In situ hydraulic conductivity tests were conducted in nine shallow monitoring wells (MW1S, MW2S, MW3S, MW4S, MW7S, MW8S, MW9S, MW10S, and MW11S), two intermediate monitoring wells (MW8M and MW11M), and three deep monitoring wells (MW1D, MW3D, and MW8D). The objective of the aquifer testing was to obtain hydraulic conductivity values for the shallow, intermediate, and deep portions of the aquifer, and to evaluate the fate and transport of contaminants in groundwater at the site.

Only rising-head tests were conducted at each monitoring well, using a stainless steel slug. This test generally provides a more accurate estimate of hydraulic conductivity than a falling-head test in wells that recover rapidly because the influence of the sandpack or unsaturated zone is reduced. Water level data were collected using a pressure transducer and data logger. Slug test data were analyzed using the Bouwer and Rice (1976) method for unconfined aquifers. The slug test data are provided in Appendix D; the aquifer test results are discussed in Section 2.2.

2.1.6 Structures Investigation

2. EE/CA Support Sampling

The structures investigation at the JW site included a structural assessment of the existing site buildings by a professional structural engineer; sediment sampling; and sampling of suspect ACM. The objectives of the structures investigation were to assess the physical integrity of existing buildings and foundations, to characterize sediments that have accumulated in man-made depositional areas, and to determine if ACM exists in on-site structures and building materials. The sediment sample locations and ACM sample locations are shown on Figures 2-5 and 2-6, respectively. A summary of the sediment and ACM samples collected and the chemical analyses performed is presented in Table 2-1. The analytical results are discussed in Section 2.2.

2.1.6.1 Structural Assessment

E & E subcontracted a professional structural engineering firm, Rubinos & Mesia Engineers, Inc. of Chicago, Illinois, to perform a structural assessment of the five on-site buildings and the two storage silos. The objective of this assessment was to evaluate the physical integrity of these structures. The assessment included a visual inspection of the structures, and written and photographic documentation of building and silo conditions. The structural assessment report is provided in Appendix E.

2.1.6.2 Sediment Sampling

A total of four sediment samples (SD01 through SD04) were collected at the site. The objective of the sediment sampling was to characterize the sediments that have accumulated in man-made depositional areas such as lagoons and sumps. All samples were collected from the top 6 inches of sediment in each structure using a trowel or shovel. The sediment sample locations are shown on Figure 2-5; a summary of the sediment samples collected and the chemical analyses performed is presented in Table 2-1. The analytical results are discussed in Section 2.2.

Samples SD01 and SD02 were collected from the north and south end, respectively, of the concrete basin. Samples SD03 and SD04 were collected from sumps located adjacent to the former PCP treatment area and the former creosote process area, respectively. All sediment samples were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, and TAL inorganics at an EPA CLP laboratory. In order to evaluate the potential treatability of sediments and to determine if they would be characteristic hazardous waste, sample SD04 was analyzed for TCLP organics and inorganics, flash point, paint filter test, ash, Btu content, and reactivity.

2.1.6.3 ACM Sampling

A total of 14 ACM samples were collected from the five on-site buildings and the collapsed pole barn. The objectives of the

2. EE/CA Support Sampling

sampling were to determine the presence or absence of asbestos in various materials present within the site buildings, and to assess the requirements for potential future removal/demolition of these site buildings. All ACM sampling was conducted in accordance with the procedures specified in the EE/CA FSP (E & E 1997). The ACM sample locations are shown on Figure 2-6; a summary of the samples collected and the analysis performed is presented in Table 2-1. The results are discussed in Section 2.2.

Two samples (OB01 and OB02) were collected from the office building, targeting floor and ceiling tile material, respectively. Four samples (BB03, BB05, BB06, and BB14) were collected from the boiler building, targeting corrugated paper, pipe insulation, pipe wrap, and roofing, respectively. Sample GB04 was collected from pipe insulation in the green building. Two samples (TB07 and TB08) were collected in and near the transite building, targeting wall board and corrugated paper, respectively. Four samples (WB09, WB10, WB11, and WB13) were collected from the white building, and targeted ceiling tile, pipe insulation, a boiler jacket, and roofing, respectively. One sample (PB12) was collected of roofing material from the collapsed pole barn. All building material samples were submitted to EO of St. Louis, Missouri, for asbestos analysis using polarized light microscopy. The EO laboratory results are provided in Appendix F.

2.2 EE/CA Support Sampling Results

The physical and analytical results of the EE/CA support sampling are discussed in this section. The physical characteristics of the site, as identified through the subsurface and hydrogeological investigations, are presented in Section 2.2.1. The chemical results of the samples collected during the EE/CA are presented in Section 2.2.2. This discussion is detailed, and focuses on the various environmental media individually. For a discussion of overall site contamination, refer to Section 4.4, which is the proposed removal action scope. A summary of the EE/CA support sampling and analysis program is presented in Table 2-1, and analytical data summary tables are provided in Appendix G.

2.2.1 Geology/Hydrogeology of the Site

During the EE/CA field investigation, approximately 120 feet of unconsolidated overburden was investigated during the soil boring and monitoring well installation programs. A review of the soil and the monitoring well boring logs (see Appendices B and C) indicates that much of the site is covered with 1 to 2 feet of gravel fill, which contains slag and cinders. The lithology from the ground surface to the water table is variable, and consists of interbedded sands, silts, and clays. These beds are typically 2 to 4 feet thick, and appear to be discontinuous across the site. Below the water table, sands are

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predominant; the grain sizes generally increase with depth and include gravels and cobbles in the deeper zones above the bedrock surface. Small lignite fragments were observed within the sands at 22 to 52 feet BGS. A competent bedrock surface was encountered at depths ranging from 113.5 feet BGS at MW5D to 117 feet BGS at MW8D. Bedrock is a grayish-white cherty limestone, as evidenced by the cobbles observed during the drilling of monitoring well MW9D.

mg/kg
milligrams per kilogram

Four subsurface soil samples (MW8S-20, MW9S-20, MW8M-53, and MW5D-108) were collected from the unconsolidated material for grain size analysis (see Appendix H for grain size analysis results). The results of the grain size analysis reflect the general trends in lithology described above. Within the shallow portion of the aquifer, sample MW8S-20 is composed of 94% fine sand and 6% silt; however, sample MW9S-20 consists of 45% fine sand, 46% silt, and 9% clay. Grain size increases with depth in the aquifer; intermediate sample MW8M-53 consists of 99% sand (10% coarse, 60% medium, and 29% fine) and 1% silt; and deep sample MW5D-108 consists of 5% fine gravel, 94% sand (4% coarse, 67% medium, and 23% fine) and 1% silt. In addition, samples MW8S-20 and MW9S-20 were also analyzed for TOC; the results were 5,600 milligrams per kilogram (mg/kg) and 5,700 mg/kg, respectively. Two subsurface soil samples, MW8S-10 and MW9S-10, were analyzed for pH; the results were 8.0 and 8.2, respectively.

Two rounds of water level measurements were collected at the site (September 5 and December 11, 1997) and included the eight new and 13 existing monitoring wells. The water levels in the three off-site wells (old 8S, old 8D, and old 10D) were not measured. A summary of the water level data is presented in Tables 2-2 and 2-3. The groundwater elevations for September 5, 1997, were used to create groundwater contour maps for the shallow and intermediate/deep portions of the aquifer (see Figures 2-7 and 2-8, respectively).

Horizontal and vertical hydraulic gradients were calculated using the September 5, 1997, groundwater elevations for both the shallow and intermediate/deep wells, and are based on the directions of groundwater flow illustrated in Figures 2-7 and 2-8. In general, groundwater flow within the shallow aquifer is toward the southwest; however, the western component of groundwater flow increases in the southern half of the site. The reason for this deflection in groundwater flow direction may be due to the significant presence of fines within the shallow aquifer (e.g., sample MW9S-20 consists of 45% fine sand, 46% silt, and 9% clay), and/or the presence of the Jennite pit producing a groundwater

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mounding effect in this area. This deflection was also observed in previous groundwater contour maps created for the site (WCC 1988). Horizontal gradients were calculated along the direction of groundwater flow in the northern, central, and southern portions of the site, and range from 0.0023 to 0.00064 feet per foot (ft/ft). in the southern and central portions of the site, respectively. The direction of groundwater flow within the intermediate/deep portions of the aquifer is also toward the southwest; however, no deflection in flow direction is present. Horizontal gradients within these portions of the aquifer appear to be consistent across the site; values along the direction of groundwater flow in the northern and southern portions of the site range between 0.00072 and 0.00081 ft/ft.

ft/ft
feet per foot

Vertical hydraulic gradients were also calculated between shallow and deep monitoring wells. At three locations (MW5S/5D, MW6S/6D, and MW8S/8D), no vertical gradient is present. In addition, gradient directions are inconsistent: at MW1S/1D, it is downward at 0.00033 ft/ft, and at MW3S/3D, it is upward at 0.00022 ft/ft. The greatest vertical gradient present at the site is at monitoring well nest MW9. Between MW9S/9D, the gradient is downward at 0.0025 ft/ft; most of this vertical movement of groundwater is present between the shallow and intermediate portions of the aquifer (MW9S/9M), where the gradient is downward at 0.0095 ft/ft.

Aquifer tests (slug tests) were used to estimate the hydraulic conductivity of the aquifer in the immediate vicinity of the well screens. For the nine shallow monitoring wells tested, all hydraulic conductivities are within one order of magnitude and range from 0.0037 feet per minute (MW9S) to 0.0263 feet per minute (MW4S). These wells are screened across sands, and the lower values represent the presence of fines within the sand (e.g., grain size analysis of MW9S-20 indicates 45% fine sand, 46% silt, and 9% clay).

Slug tests were also performed in two intermediate and three deep monitoring wells; however, the conductivities within these portions of the aquifer exceeded the test method capabilities. The plots of time versus displacement (see Appendix D) display a sinusoidal wave, indicating that the highly permeable formation surrounding the well allows the groundwater to flush in and out of the well once displacement is initiated. An estimate of hydraulic conductivity can be obtained from grain size analysis data using the following relationship (Freeze and Cherry 1979):

$$K = A(d_{10})^2$$

where:

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- K = hydraulic conductivity in centimeters per second;
A = coefficient equal to 1.0; and
 d_{10} = grain size diameter in millimeters at which 10% of the soil particles are finer by weight.

Use of the grain size data for samples MW8M-53 and MW5D-108 produces a hydraulic conductivity value of approximately 0.147 feet per minute for both the intermediate and deep portions of the aquifer. This is an order of magnitude greater than the conductivities obtained for the shallow aquifer.

An estimate of groundwater velocity was made using the following formula (Heath 1983):

$$V = K/n \times dh/dl$$

where:

- V = groundwater velocity in feet per day;
K = hydraulic conductivity in feet per day;
dh/dl = hydraulic gradient; and
n = effective porosity of the aquifer.

A groundwater velocity in the shallow portion of the aquifer was calculated using an average hydraulic gradient value of 0.0013 ft/ft, an average hydraulic conductivity value of 0.0179 feet per minute, and an assumed effective porosity of 30% (Fetter 1980). With these values, a groundwater velocity of 0.112 feet per day (approximately 41 feet per year) is estimated for the shallow portion of the aquifer. A groundwater velocity in the intermediate/deep portions of the aquifer was calculated using an average hydraulic gradient value of 0.00077 ft/ft, a hydraulic conductivity value of 0.147 feet per minute, and an assumed effective porosity of 30%. Using these values, a groundwater velocity of 0.54 feet per day (approximately 198 feet per year) is estimated for the intermediate/deep portions of the aquifer.

2.2.2 Analytical Results

EE/CA support sampling was conducted between July and September 1997. Additional fieldwork was also conducted in December 1997. During these sampling events, the following numbers of samples were collected (not including duplicates or quality control samples): 81 gridded surface soil samples, 11 biased surface soil samples, four off-site surface soil samples, 58 subsurface soil samples, 37 Geoprobe groundwater samples, four sediment samples, 24 monitoring well groundwater samples, and 14 building material samples for asbestos analysis. The analytical results of these samples are discussed in this section.

2.2.2.1 Surface Soil Samples

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Gridded Samples. A total of 81 gridded surface soil samples were collected at node locations defined by the site sampling grid. All of the samples received PCP and PAH screening analysis; 16 of the samples were also submitted for full TCL/TAL analysis. Analytical data summary tables of the gridded surface soil samples are presented in Appendix G. A summary of the PCP immunoassay screening results is presented in Table 2-4. Table 2-5 summarizes the results for the remaining analytical parameters.

ppm
parts per million

PCP (screening). As shown in Table 2-4, PCP was detected at a concentration greater than 0.5 parts per million (ppm) (the low end of the immunoassay test range) in 55 of the 81 samples. Forty-one of these samples had a concentration within the >0.5 ppm and <5 ppm range; these sample locations were widespread across the site. Ten of the 55 samples had a concentration within the >5 ppm and <50 ppm range, and were generally located in the vicinity of tram rail tracks (former and existing). Four of the 55 samples (SS01, SS05, SS06, and SS22) had a concentration greater than 50 ppm. These samples were located in the vicinity of the 22nd Street lagoon and Area H.

PAH (screening). As shown in Table 2-5, at least one PAH was detected in 76 of the 81 gridded surface soil samples. Benzo(b)fluoranthene, benzo(a)pyrene, benzo(k)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene were the most frequently detected PAHs, found in a minimum of 73 of the 81 samples. The highest total PAH concentrations were detected in samples SS17 (17,314 mg/kg), SS11 (14,064 mg/kg), SS24 (6,144 mg/kg), SS16 (4,046 mg/kg), and SS05 (3,755 mg/kg), all located in the northern portion of the site, either along the former tram tracks or the north fenceline. Based on historical aerial photographs, treated lumber was stored along the site's north fenceline. Drippings from this stored wood likely account for the elevated PAH concentrations detected here. The highest total PAH concentration in the southern portion of the site was detected in sample SS22 (3,390 mg/kg), near the 22nd Street lagoon.

VOCs. A total of seven VOCs were detected in the gridded surface soil samples. Five of these compounds were detected at a maximum concentration of less than 10 µg/kg, and typically only in sample SS05, along the north fenceline. This sample also contained xylene at a concentration of 97 µg/kg. Toluene was the most frequently detected VOC being detected in 15 of the 16 samples submitted for VOC analysis. The maximum concentration of 69 µg/kg was detected in sample SS80, along the west fenceline, south of 21st Street.

SVOCs. Twenty-four SVOCs were detected in the gridded surface

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soil samples. The most frequently detected SVOCs were the 17 PAH compounds. The 17 PAH compounds are listed in Table 2-6. The highest total PAH concentrations were detected in samples SS05 (2,163,000 $\mu\text{g/kg}$), SS10 (935,540 $\mu\text{g/kg}$), SS39 (681,300 $\mu\text{g/kg}$), SS15 (672,155 $\mu\text{g/kg}$), SS35 (510,850 $\mu\text{g/kg}$), and SS25 (462,630 $\mu\text{g/kg}$). Most of these samples were collected from the northern portion of the site, either adjacent to the debris pile, or along former tram tracks or the north fenceline. Sample SS39 was located along formerly present tram tracks associated with the concrete basin. PCP was detected in only one sample, SS15, at a concentration of 3,200 $\mu\text{g/kg}$. In general, the remaining SVOCs were detected at a lower frequency and at concentrations at least an order of magnitude less than those of the PAH compounds. However, the maximum SVOC concentration locations were those where high total PAH concentrations were identified (i.e., SS05, SS15, and SS39).

Pesticide/PCB. A total of 19 pesticides were detected in the gridded surface soil samples. No PCB compounds were detected. The maximum concentrations of pesticides ranged from 2.6 $\mu\text{g/kg}$ for gamma-BHC (Lindane) to 660 $\mu\text{g/kg}$ for methoxychlor. Most of the compounds were detected at a limited frequency; however, six pesticides (dieldrin, endrin, endrin ketone, 4,4'-DDT, endrin aldehyde, and endosulfan II) were detected in more than half of the samples. The locations of the maximum pesticide concentrations suggest a site-wide distribution of pesticides.

Inorganics. A total of 24 TAL analytes were detected in the gridded surface soil samples. The maximum concentrations of inorganics ranged from 0.2 mg/kg for mercury to 177,000 mg/kg for calcium. The sample locations containing the maximum concentrations were generally in the northern portion of the site. Samples SS45, SS55, and SS80 contained the maximum concentrations of 14 of the 24 inorganics, including antimony, beryllium, chromium, cobalt, iron, lead, mercury, vanadium, and zinc.

Biased Samples. A total of 11 surface soil samples were collected at biased locations not defined by the grid system. These samples targeted known disposal areas, suspected spill areas, and areas of visual surficial contamination. All of the samples were submitted for TCL/TAL and dioxin/furan analysis. One sample was also selected for TCLP/disposal parameter analysis. Analytical data summary tables for the biased surface soil samples are provided in Appendix G; a summary of these results is presented in Table 2-7.

VOCs. A total of nine VOCs were detected in the biased surface soil samples. Five of these compounds were detected at a

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maximum concentration of less than 10 µg/kg. Toluene was the most frequently detected VOC being detected in 8 of the 11 biased surface soil samples collected. The maximum concentration of 880 µg/kg was detected in sample SS89. Sample SS89, collected from an area of stained soils in the northern portion of the site, also contained the maximum concentrations of ethylbenzene (1,000 µg/kg), styrene (860 µg/kg), and xylene (3,000 µg/kg).

SVOCs. Twenty-five SVOCs were detected in the biased surface soil samples. The most frequently detected SVOCs were the 17 PAH compounds listed in Table 2-6. The highest total PAH concentrations were detected in samples SS89 (189,190,000 µg/kg) and SS88 (173,020,000 µg/kg). Both of these samples were collected from stained soil areas present along tram rail in the northern portion of the site. Other samples with high total PAH concentrations included samples SS86 (1,657,900 µg/kg) and SS96 (1,369,000 µg/kg), collected from Area H and the debris pile in the southern corner of the site, respectively. PCP was detected in six of the 11 samples, with concentrations ranging from 3,600 µg/kg in sample SS85 to 520,000 µg/kg in sample SS95. All of the samples containing PCP were collected from one of the following three areas: 22nd Street lagoon, Area H, or adjacent to the former PCP process area (Area C). In general, the remaining SVOCs were detected at a lower frequency and at concentrations several orders of magnitude less than those of the PAH compounds.

Pesticide/PCB. A total of 17 pesticides were detected in the biased surface soil samples. No PCB compounds were detected. The maximum concentrations of pesticides ranged from 3.1 µg/kg for gamma-BHC (Lindane) to 1,000 µg/kg for endrin. Most of the compounds were detected at a limited frequency; however, six pesticides (heptachlor epoxide, endrin, endosulfan II, 4,4'-DDD, 4,4'-DDT, and endrin ketone) were detected in more than half of the samples. In general, the locations containing the highest pesticide concentrations were SS88, SS89, and SS95, where high concentrations of other organic contaminants also were identified.

Inorganics. A total of 24 TAL analytes were detected in the biased surface soil samples. The maximum concentrations of inorganics ranged from 0.4 mg/kg for mercury and silver to 40,300 mg/kg for iron. The samples containing the maximum inorganic concentrations were generally located in the known disposal areas of the site (i.e., the 22nd Street lagoon, Area H, and the debris pile located at the southern end of the site). Samples SS85 and SS96 contained the maximum concentrations of 16 of the 24 inorganics, including arsenic, barium, beryllium, chromium, copper, iron, manganese, mercury, and vanadium. Inorganic concentrations detected in the biased surface soil samples were generally compara-

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ble to those detected in the gridded surface soil samples; however, many of the maximum inorganic concentrations for the site were detected in the gridded samples.

HxCDF

123678-Hexachloro-dibenzofuran

OCDD

octachlorodibenzo-p-dioxin

OCDF

octachlorodibenzofuran

HpCDD

1234678-Heptachloro-dibenzo-p-dioxin

TCDD

2378-Tetrachloro-dibenzo-p-dioxin

TEF

Toxicity Equivalency Factor

TCDF

2378-Tetrachlorodibenzofuran

PeCDF

12378-Pentachloro-dibenzofuran

PeCDD

12378-Pentachloro-dibenzo-p-dioxin

HxCDD

123478-Hexachloro-dibenzo-p-dioxin

HpCDF

1234678-Heptachloro-dibenzofuran

Dioxin/Furan. Eleven dioxin/furan compounds were identified in the biased surface soil samples. The maximum concentrations for each compound ranged from 1.9918 µg/kg for 123678-hexachlorodibenzofuran (HxCDF) to 29,573.46 µg/kg for octachlorodibenzo-p-dioxin (OCDD). OCDD, octachlorodibenzofuran (OCDF), and 1234678-heptachlorodibenzo-p-dioxin (HpCDD) were detected in each of the 12 samples. Sample SS95, collected in the former PCP process area, contained the maximum concentration of each compound detected. The 2378-tetrachlorodibenzo-p-dioxin (TCDD) Toxicity Equivalency Factor (TEF)-adjusted concentrations for the 12 samples are shown in Table 2-8. The TEF procedure involves multiplying the concentration of dioxin/furan compound in a sample by its TEF to express the concentration in terms of 2378-TCDD equivalents. The 2378-TCDD equivalents are then summed for each compound to obtain the total TEFs in a sample. The following TEFs have been assigned by EPA to the various dioxin/furan compounds:

- 2378-TCDD (TEF = 1.0);
- 2378-Tetrachlorodibenzofuran (TCDF) (TEF = 0.1);
- 12378-Pentachlorodibenzofuran (PeCDF) (TEF = 0.05);
- 12378-Pentachlorodibenzo-p-dioxin (PeCDD) (TEF = 0.5);
- 23478-PeCDF (TEF = 0.5);
- 123478-HxCDF (TEF = 0.1);
- 123678-HxCDF (TEF = 0.1);
- 123478-Hexachlorodibenzo-p-dioxin (HxCDD) (TEF = 0.1);
- 123678-HxCDD (TEF = 0.1);
- 123789-HxCDD (TEF = 0.1);
- 234678-HxCDF (TEF 0.1);
- 123789-HxCDF (TEF = 0.1);
- 1234678-Heptachlorodibenzofuran (HpCDF) (TEF = 0.01);
- 1234678-HpCDD (TEF = 0.01);
- 12346789-HpCDF (TEF = 0.01);
- OCDD-(TEF = 0.001); and
- OCDF-(TEF = 0.001).

TCLP/Disposal Parameters. One biased surface soil sample (SS89) was submitted for full TCLP and disposal parameter analysis. The results of this testing are shown in Table 2-9. This sample was not a characteristic hazardous waste based on the TCLP results.

Off-Site Samples. A total of four off-site surface soil samples were collected. The four samples were submitted to E & E's ASC

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for TAL metals analysis. An analytical data summary table for the off-site surface soil samples is provided in Appendix G; a summary of these results is presented in Table 2-10. The only TAL metals not detected in at least one of the off-site surface soil samples were antimony, beryllium, and silver.

These surface soil sample results indicate a widespread presence of contaminants at the site; however, localized areas of high contaminant levels were identified. In the northern portion of the site, high levels of PCP and PAHs are present in surface soils adjacent to the tram rail tracks (former and existing), as well as along the north fenceline. These areas were historically used in the transfer and storage of treated lumber. Other site areas with significant PCP and/or PAH surface soil contamination include the known disposal areas of the site (e.g., Area H, the 22nd Street lagoon, and the former PCP process area (Area C)). The results indicate that these disposal areas were also typically impacted by inorganic contaminants and dioxin/furan compounds. Limited VOC and SVOC contamination was also identified in these localized areas, but at relatively lower concentrations.

2.2.2.2 Subsurface Soil Samples

A total of 58 Geoprobe subsurface soil samples and 14 drill rig subsurface soil samples were collected at the site. All of the Geoprobe subsurface soil samples received PCP and PAH screening analysis; 12 of these samples were also submitted for full TCL/TAL analysis. Drill rig subsurface soil samples collected from borings SB31 through SB34 were analyzed for full TCL/TAL parameters, with selected samples also submitted for TCLP/disposal and biological parameter analyses. Drill rig subsurface soil samples collected from monitoring well borings MW8S and MW9S were submitted for SVOC analysis only. Analytical data summary tables for the subsurface soil samples are presented in Appendix G. A summary of the PCP immunoassay results is presented in Table 2-4. Table 2-11 summarizes the results for the remaining analytical parameters.

PCP (screening). PCP was detected at an immunoassay screening concentration greater than 0.5 ppm in only four of the 58 Geoprobe subsurface soil samples. Two of these samples (SB01 [12-13] and SB26 [11-12]) had a PCP concentration within the >0.5 ppm and <5 ppm range. Soil boring SB01 was located adjacent to the 22nd Street lagoon; and soil boring SB26 was located adjacent to the northeast corner of the concrete basin. The remaining two samples (SB03 [12-13] and SB16 [6-7]) had PCP concentrations greater than 50 ppm. Soil boring SB03 was located adjacent to the former PCP process area, and soil boring SB16 was located adjacent to a concrete sump, approximately 25 feet west of the west silo.

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PAH (screening). PAHs were detected in 12 of the 58 Geoprobe subsurface soil samples. Soil borings SB01, SB03, SB14, SB16, SB24, SB26, SB27, and SB30 contained PAH compounds in at least one depth sample interval. Phenanthrene, fluoranthene, benzo(a)anthracene, chrysene, and benzo(a)pyrene were the most frequently detected PAHs, found in 11 of the 58 samples. The highest total PAH screening concentrations were detected in samples SB26 (11-12) (719,075 mg/kg) and SB27 (5-6) (501,178 mg/kg). Both of these borings were in the general vicinity of the former creosote process area. Total PAH concentrations in the remaining samples ranged from 3.4 mg/kg in SB24 (12-13) to 5,803 mg/kg in SB16 (6-7).

VOCs. A total of 11 VOCs were detected in the subsurface soil samples. Six of these compounds were detected at a maximum concentration of 10 µg/kg. For the remaining VOC compounds, the maximum concentrations ranged from 4,050 µg/kg for benzene to 30,500 µg/kg for xylene. These maximum VOC concentrations were detected in sample SB32 (8-10), collected from the 22nd Street lagoon.

SVOCs. Twenty-six SVOCs were detected in the subsurface soil samples. The most frequently detected compounds were naphthalene, phenanthrene, and fluoranthene, found in a minimum of 10 of the 24 subsurface soil samples analyzed for SVOCs. The highest total PAH concentrations were detected in samples SB33 (6-8) (1,341,500 µg/kg) and SB32 (8-10) (1,128,500 µg/kg), located beneath the concrete basin and within the boundary of the former 22nd Street lagoon, respectively. PCP was detected in three samples (SB08 [6-8], SB32 [8-10], and MW8S-15) at concentrations ranging from 24 µg/kg at SB08 to 61,500 µg/kg at SB32.

Pesticide/PCB. A total of eight pesticides were detected in the subsurface soil samples. No PCB compounds were detected. The maximum concentrations of pesticides ranged from 2.1 µg/kg for 4,4'-DDE to 390 µg/kg for methoxychlor. The most frequently detected pesticides were dieldrin, endrin ketone, and gamma-chlordane, each found in three of the 16 subsurface soil samples analyzed for pesticides. Although their presence in the subsurface is limited, the locations of the pesticide detections suggest a site-wide distribution.

Inorganics. A total of 20 TAL analytes were detected in the subsurface soil samples. The maximum concentrations of inorganics ranged from 0.1 mg/kg for cyanide to 19,400 mg/kg for iron. The maximum inorganic concentrations were typically detected in shallow depth intervals (i.e. 6 to 8 feet BGS or 5 to 7

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feet BGS). The maximum concentration of most analytes was detected most frequently in sample SB33 (6-8). This soil boring was advanced with a drill rig at an angle of 30° beneath the concrete basin in the former creosote process area. This sample contained the maximum concentrations of nine of the 20 inorganics, including barium, beryllium, chromium, cobalt, copper, iron, nickel, vanadium, and zinc.

TCLP/Disposal Parameters. One subsurface soil sample (SB32[8-10]) was submitted for full TCLP and disposal parameter analysis. The results of this testing are shown in Table 2-9. This sample was not a characteristic hazardous waste based on the TCLP results.

Biofeasibility Study. The results of the biofeasibility study are presented in Section 2.3.

These subsurface soil sample results do not indicate a widespread presence of contaminants in the unsaturated subsurface soil at the site. Like the surface soil sample results, however, localized areas of high contaminant levels were identified. PCP and PAH contaminants are present in subsurface soils associated with the 22nd Street lagoon and the former PCP process area, as well as in subsurface soils beneath the concrete basin and in the vicinity of the concrete sump near the silos. VOC, SVOC, and inorganic contaminants were also identified within these areas. The results indicate that these subsurface soil contaminants are present in both the shallow (5 to 7 feet BGS) and deep (11 to 13 feet BGS) unsaturated zones.

2.2.2.3 Geoprobe Groundwater Samples

Twenty-three Geoprobe groundwater screening samples were collected at on-site locations during July and August 1997 fieldwork. An additional 14 Geoprobe groundwater samples were collected at on- and off-site locations during the September and December 1997 fieldwork. All of the samples received PAH screening analysis at the ASC. Twenty-three groundwater samples collected from locations GP01 through GP20 received PCP immunoassay screening at the on-site field laboratory. Fourteen groundwater samples collected from locations GP32 through GP42 were analyzed for PCP by E & E's ASC (EPA Method 8270). Four of the Geoprobe groundwater samples were also submitted for full TCL/TAL analysis. Analytical data summary tables for the Geoprobe groundwater screening samples are presented in Appendix G. A summary of the PCP immunoassay field screening results is presented in Table 2-12. Table 2-13 summarizes the results for the remaining analytical parameters.

ppb
parts per billion.

PCP (field screening). PCP was detected at a concentration

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greater than 5.0 parts per billion (ppb) in 15 of the 23 samples analyzed for PCP using the immunoassay screening method. Six of these samples had a concentration within the >5.0 ppb and <50 ppb range. One sample (GP04-25) had a concentration within the >50 ppb and <100 ppb range. Eight samples, all located in the southern portion of the site, had a PCP-screening concentration greater than 100 ppb. PCP concentrations greater than 100 ppb were detected at depths up to 40 feet in the vicinity of the 22nd Street lagoon, the former creosote process area, and within the old PCP treatment area.

PCP (ASC screening). Of the 14 samples analyzed for PCP by E & E's ASC, only sample GP38-24 contained PCP (430 µg/L). PCP was not detected in the 40-foot groundwater sample collected from location GP38. Geoprobe location GP38 was situated downgradient of the 22nd Street lagoon, adjacent to the east side of the boiler building.

The presence of PCP in only one of 14 samples is an artifact of the sampling strategy chosen for the September and December 1997 fieldwork. None of these samples were collected from areas previously investigated during the field screening activities. The purpose of these ASC screening samples was to address on-site data gaps from the July and August 1997 Geoprobe groundwater investigation, as well as to investigate off-site areas hydraulically downgradient of the site in order to more fully define the extent of groundwater contamination. Based on the properties of PCP and the site's hydraulic regime, the presence of PCP was not anticipated at locations far off site. Most of the on-site sample locations were placed in areas where previous groundwater PCP concentrations were relatively low (i.e., north of 22nd Street, near the pole barn, in the southern corner of the site). However, sample location GP38 was an exception; it was located hydraulically downgradient of the 22nd Street lagoon.

PAH (screening). PAHs were detected in eight of the 37 Geoprobe groundwater samples. Naphthalene was the most frequently detected compound, found in five of the samples. The highest total PAH concentrations were detected in sample GP01-40 (4,924 µg/L), collected adjacent to the 22nd Street lagoon, and in sample GP38-24 (4,530 µg/L), collected east of the boiler building, downgradient of the 22nd Street lagoon. The remaining samples had total PAH concentrations ranging from 2.3 µg/L (GP03-40) to 957 µg/L (GP08-24).

VOCs. A total of seven VOCs were detected in the four Geoprobe groundwater samples submitted for CLP analysis.

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In sample GP08-24, the detected concentration of benzene (6,600 µg/L) exceeded the MCL of 5 µg/L, the detected concentration of toluene (3,400 µg/L) exceeded the Maximum Contaminant Level (MCL) of 1,000 µg/L, and the detected concentration of ethylbenzene (800 µg/L) exceeded the MCL of 700 µg/L.

MCL
Maximum Contaminant
Level

SMCLs
Secondary Maximum
Contaminant Levels

TCE
trichloroethene

With the exception of methylene chloride for which the maximum concentration was detected in sample GP18-24, all of the VOC compounds were detected at their maximum concentrations in sample GP08-24, collected east of the office building, near the empty UST.

SVOCs. A total of six SVOCs were detected in the four Geoprobe groundwater samples submitted for CLP analysis. Only two of the detected compounds, naphthalene and 2-methylnaphthalene, are PAHs. With the exception of di-n-butylphthalate present in sample GP18-24, all of the SVOC compounds were detected in sample GP08-24. The total PAH concentration for this sample was 106 µg/L. PCP was not detected in any of the four samples.

Pesticide/PCB. Only one pesticide was detected in the four samples. Heptachlor was present at a concentration of 0.13 µg/L in sample GP08-24. This concentration is below the MCL of 0.4 µg/L.

Inorganics. A total of 17 TAL analytes were detected in the four Geoprobe groundwater samples submitted for CLP analysis. Maximum inorganic concentrations ranged from 2.9 µg/L for antimony to 308,000 µg/L for calcium. All four samples (GP07-20, GP08-24, GP12-24, and GP18-24) had iron and manganese concentrations above the Secondary Maximum Contaminant Levels (SMCLs) of 300 µg/L and 50 µg/L, respectively. MCLs have not been established for iron and manganese. In addition, samples GP08-24, GP12-24, and GP18-24 had a thallium concentration which exceeded the MCL of 2 µg/L. Thallium was the only inorganic for which an MCL exceedance was noted.

2.2.2.4 Monitoring Well Groundwater Samples

A total of 21 groundwater samples were collected from the on-site monitoring wells and analyzed for the full TCL/TAL. Analytical data summary tables for the monitoring well groundwater samples are presented in Appendix G. A summary of these results is presented in Table 2-14.

VOCs. A total of 14 VOCs were detected in the groundwater samples. For evaluation purposes, the monitoring well groundwater results were compared to MCLs.

2. EE/CA Support Sampling

Shallow Monitoring Wells. The following VOCs were detected above their respective MCLs in the shallow monitoring wells: benzene (930 µg/L in MW5S and 9 µg/L in MW8S), and trichloroethene (TCE) (9 µg/L in MW-8S). The MCLs for these VOCs are: benzene (5 µg/L) and TCE (5 µg/L). Monitoring well MW5S, which is located adjacent to the 22nd Street lagoon, is the most contaminated shallow well on site with respect to VOCs. The following VOCs were detected in this well: benzene (930 µg/L), ethylbenzene (66 µg/L), methylene chloride (24 µg/L), styrene (65 µg/L), toluene (450 µg/L), and xylenes (240 µg/L). Monitoring well MW8S, located in the former PCP process area, also contained significant VOC contamination with the following compounds detected: 2-butanone (59 µg/L), 4-methyl-2-pentanone (19 µg/L), acetone (89 µg/L), benzene (9 µg/L), ethylbenzene (18 µg/L), methylene chloride (2 µg/L), toluene (65 µg/L), TCE (9 µg/L), and xylenes (120 µg/L).

1,2-DCA
1,2-dichloroethane

BaP
benzo(a)pyrene

Intermediate Monitoring Wells. VOC contamination was detected in several of the intermediate monitoring wells. Monitoring well MW6M, located downgradient of the former creosote process area, contained the following VOCs: 1,2-dichloroethane (1,2-DCA) (12 µg/L), benzene (75 µg/L), and methylene chloride (8 µg/L). The concentrations of 1,2-DCA and benzene were above MCLs. Monitoring well MW9M, located downgradient of the Jennite pit, contained the following VOCs: 1,2-DCA (3 µg/L), carbon disulfide (2 µg/L), ethylbenzene (3 µg/L), methylene chloride (2 µg/L), styrene (9 µg/L), toluene (2 µg/L), and xylenes (14 µg/L). None of these detections exceeded MCLs.

Deep Monitoring Wells. VOC contamination was also detected in several of the deep monitoring wells. Monitoring well MW5D, located near the 22nd Street lagoon, contained the following VOCs: ethylbenzene (2 µg/L), methylene chloride (2 µg/L), and xylenes (7 µg/L). Monitoring wells MW1D, MW5D, MW8D, MW9D, and MW6D all contained methylene chloride at concentrations below 10 µg/L. None of these detections exceeded MCLs.

SVOCs. A total of 23 SVOCs were detected in the groundwater samples. Sixteen of these 23 compounds are PAHs. For evaluation purposes, the concentration of total PAHs in each of the monitoring wells was calculated. Also, the concentrations of PCP and benzo(a)pyrene (BaP) in each of the groundwater samples was compared to the MCLs of 1.0 µg/l and 0.2 µg/L, respectively. BaP is the only PAH with an established MCL.

Shallow Monitoring Wells. The concentrations of total PAHs in

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the shallow wells were as follows: MW5S (125,000 µg/L), MW9S (21 µg/L), and MW2S (14 µg/L). None of the other shallow monitoring wells contained any PAHs. However, the PAH detection limits in the sample collected from well MW8S were elevated to the 20,000 to 50,000 µg/L range due to a high concentration of PCP. PCP was detected at concentrations exceeding the MCL of 1 µg/L in the following monitoring wells: MW8S (88,000 µg/L), MW5S (1,400 µg/L), and MW2S (48 µg/L). BaP was not detected in any shallow groundwater sample.

Intermediate Monitoring Wells. The concentrations of total PAHs in the intermediate monitoring wells were as follows: MW8M (198 µg/L) and MW9M (10 µg/L). None of the other intermediate monitoring wells contained any PAHs. Also, PCP and BaP were not detected in any intermediate groundwater sample.

Deep Monitoring Wells. In the deep monitoring wells, PAHs and PCP were detected only in well MW5D. The total PAH concentration in this well was 2,225 µg/L, the PCP concentration was 13 µg/L, and the BaP concentration was 2 µg/L. The PCP and BaP concentrations exceed the respective MCLs.

Pesticide/PCB. A total of five pesticides were detected in the on-site monitoring wells. No PCB compounds were detected. For pesticides, no exceedances of MCLs were noted in any groundwater sample.

Shallow Monitoring Wells. The following pesticides were detected in the shallow monitoring wells: alpha-BHC (0.26 µg/L in MW8S), gamma-BHC (lindane) (0.089 µg/L in MW5S), heptachlor (0.13 µg/L in MW5S), and alpha-chlordane (0.17 µg/L in MW5S).

Intermediate Monitoring Wells. Pesticides were not detected in any of the intermediate wells.

Deep Monitoring Wells. Endosulfan I (0.12 µg/L in well MW5D) was the only pesticide detected in the deep monitoring wells.

Inorganics. A total of 20 TAL analytes were detected in the groundwater samples. The only TAL analytes not detected in at least one of the samples were antimony, beryllium, mercury, and thallium. No TAL analytes were detected above MCLs. However, lead was detected above its action level of 15 µg/L in several monitoring wells. For lead, an action level rather than an MCL has been established by EPA. The difference between an action level and an MCL is that an exceedance of an MCL in a public water system is a violation of the Safe Drinking Water Act, but an exceedance of an action level is not a violation of the act. Rather,

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in the event an action level is exceeded, the municipality operating the public water system must treat the water to achieve concentrations below the action level.

Shallow Monitoring Wells. Lead was detected in the following shallow wells above its action level of 15 µg/L: MW6S (49.7 µg/L), MW7S (52.2 µg/L), and MW8S (55.9 µg/L).

Intermediate Monitoring Wells. Lead was not detected above its action level in any of the intermediate wells.

Deep Monitoring Wells. Lead was detected in the following deep wells above its action level of 15 µg/L: MW6D (19.5 µg/L) and MW9D (51.2 µg/L).

The results of the groundwater samples collected from both the Geoprobe and monitoring well locations indicate a contaminant distribution similar to that observed in the subsurface soils. In shallow groundwater, PCP contamination is highest in the vicinity of the former PCP process area and the 22nd Street lagoon. Lower PCP concentrations are present in the vicinity of the concrete sump near the silos and Area H. The results of groundwater samples collected from locations downgradient of these areas indicate that migration of PCP has occurred within this shallow zone; however, PCP concentrations are significantly lower in the intermediate groundwater samples collected in these areas, suggesting that limited downward migration of PCP has occurred at the site.

The groundwater PAH results show a different distribution. In shallow groundwater, PAH contamination is highest in the vicinity of the 22nd Street lagoon, with lower concentrations present in the vicinity of Area H and the Jennite pit. The results of groundwater samples collected from locations downgradient of these areas indicate that limited migration of PAHs has occurred within this shallow zone; however, high PAH concentrations are still present in the intermediate and deep groundwater samples collected in the vicinity of the 22nd Street lagoon, suggesting that downward migration of PAHs has occurred at the site. PAH contamination was also detected in intermediate groundwater samples collected in the vicinity of the former PCP process area.

Limited VOC, SVOC, and inorganic contamination was also identified in the groundwater samples collected at the site. Most of these contaminants were detected in the PCP- and/or PAH-impacted areas. These contaminants were typically present at their highest concentrations in the shallow groundwater, and their concentrations decreased with depth in the aquifer.

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2.2.2.5 Sediment Samples

A total of four sediment samples (SD01 through SD04) were collected. In addition, sample SD05 was collected as a duplicate of sample SD04. Samples SD01 and SD02 were collected from the north and south ends of the concrete basin, respectively. Sample SD03 was collected from the rectangular concrete pit. Sample SD04 was collected from the oval sump located in the former creosote process area.

All four sediment samples were submitted for full TCL/TAL analysis. In addition, because of the waste-like appearance of this sample, sediment sample SD04 was submitted for TCLP and disposal parameter analysis. Analytical data summary tables for the sediment samples are presented in Appendix G. A summary of the TCLP and disposal parameter results is presented in Table 2-9. Table 2-15 summarized the results for the remaining analytical parameters.

BTEX
benzene, toluene,
ethylbenzene, and
xylene

VOCs. A total of eight VOCs were detected in the sediment samples. The VOCs detected included methylene chloride, acetone, chloroform, styrene, and benzene, toluene, ethyl- benzene, and xylene (BTEX). All four BTEX compounds were detected in samples SD03 and SD04, with the maximum detected BTEX concentration being 220,800 µg/kg in sample SD03.

SVOCs. A total of 22 SVOCs were detected in the sediment samples. Most of the SVOCs detected were PAHs. The PAH results were extremely elevated in all four samples, exceeding one percent for individual compounds in some cases. For example, naphthalene was detected at a concentration of 13,000,000 µg/kg (1.3%) in sample SD03, phenanthrene was detected at a concentration of 30,000,000 µg/kg (3%) in sample SD04, fluoranthene was detected at a concentration of 25,000,000 µg/kg (2.5%) in sample SD02, and pyrene was detected at a concentration of 16,000,000 µg/kg (1.6%) in sample SD02. However, despite these high concentrations, sample SD04 is not considered a characteristic hazardous waste based on the results of TCLP testing (see Table 2-9).

Pesticides/PCBs. All of the pesticide compounds on the TCL were detected in at least one of the sediment samples. No PCBs, however, were detected in any of the four sediment samples collected. The following pesticide compounds were detected at the highest levels. Endrin aldehyde was detected in all four samples, with the highest concentration detected being 500 µg/kg in sample SD04. The pesticide 4,4'-DDT was detected in three of the samples, with the highest concentration detected being 200 µg/kg in sample SD02. Endrin was detected in all four samples, with the

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highest concentration detected being 280 µg/kg in sample SD02.

Inorganics. Silver was the only TAL analyte not detected in at least one of the sediment samples. The maximum concentrations of inorganics ranged from 1.7 mg/kg for mercury to 63,400 mg/kg for iron. Overall, the maximum inorganic concentrations were detected in sample SD04.

These sediment sample results confirm that these structures were associated with site processes, and have been impacted by former site activities. VOC and SVOC contaminants are present in the sediment that has accumulated in each of these structures, with sediments containing up to 3% of a single PAH compound. However, the results of the TCLP and disposal parameter analyses indicate that these sediments are not a characteristic hazardous waste.

2.2.2.6 Building Material Samples

A total of 14 building material samples (e.g., roofing, ceiling and floor tile, pipe insulation) were collected and analyzed for asbestos. Based upon analytical results of the 14 building material samples collected, six samples were classified as ACM based on the percentage of asbestos detected (greater than 1%). Sample OB01, a sample of floor tile from the office building, contained chrysotile at 2%. Sample BB03, a corrugated paper pipe insulation found in the boiler building, contained chrysotile at 18%. Sample BB05, a white chalky pipe insulation found in the boiler building, contained chrysotile at 38%. Sample TB07, a sample of the transite panels found on the walls of the transite building, contained chrysotile at 19%. Sample WB10, pipe insulation found in the white building, contained chrysotile at 16%. Sample WB11, collected from the jacket of a boiler present in the white building, contained amosite at 8%.

A summary of the asbestos sample results is presented in Table 2-16. The asbestos laboratory report can be found in Appendix F.

2.3 Biofeasibility Study Results

A bench-scale biofeasibility study was conducted by the MiL using two soil samples (SB32[6-7] and SB33[12-13]), two groundwater samples (MW5S and MW10S), and NAPL collected from monitoring well MW5S. The MiL's report is provided in Appendix K. The objectives of the study were to identify bacterial strains present in on-site soil and groundwater, and determine the potential effectiveness and feasibility of bioremediation for the site.

TSA
trypticase soy agar

Within 20 minutes of sample receipt, an aliquot from each soil and groundwater sample was checked by the MiL for volume and



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weight, then placed on a dried trypticase soy agar (TSA) medium in Petri plates. Observations for colony forming units (CFUs) were made after 24 and 48 hours of incubation at 28°C.

CFUs
colony forming units

Using the CFUs, the MiL next identified a total of seven morphologically different bacterial strains among the four samples. These strains were identified as 4881-1 through 4881-7, with 4881 being the MiL's project number for this study. Only soil sample, SB32(6-7), contained all seven strains. Soil sample SB33(12-13) contained three strains (strains 4881-2, 4881-4, and 4881-5), and groundwater samples MW5S and MW10S contained two strains each (strains 4881-5 and 4881-6, and strains 4881-4 and 4881-5, respectively). Only one strain (strain 4881-5) was found in all four samples, which was an early indication that this strain is successfully using the contamination at the JW site as a carbon source.

Following isolation, the strains were individually streaked onto TSA, incubated for 24 hours, and processed using bacterial databases for identification purposes. The seven strains were identified as follows:

- Strain 4881-1: *Bacillus mycoides* subgroup B;
- Strain 4881-2: *Bacillus subtilis*;
- Strain 4881-3: *Bacillus megaterium* subgroup A;
- Strain 4881-4: *Bacillus badius*;
- Strain 4881-5: *Alcaligenes eutrophus*;
- Strain 4881-6: *Pseudomonas putida* biotype A; and
- Strain 4881-7: *Bacillus circulans*.

The seven identified strains were grown for 18 hours on TSA at 28 °C, then suspended in sterile saline. The suspended strains were next placed into a plate consisting of 96 wells. Each well had a volume of 150 microliters. The wells contained a growth medium of mineral salts, vitamins, and buffer, but contained no major carbon source. The wells also contained a tetrazolium dye. Bacterial growth was monitored by the amount of tetrazolium reduction. NAPL obtained from on-site monitoring well MW5S was added to selected wells to serve as the major carbon source for those wells. Positive and negative growth controls were also added. Of the seven strains identified, only strain 4881-5 (*Alcaligenes eutrophus*) showed an excellent growth rate using the



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NAPL as a carbon source. The growth rates of the other six strains were described as inhibited. Based on *Alicyclobacillus eutrophus*' ability to use site NAPL as a carbon source, it was concluded that the JW site appears to be a good candidate for bioremediation.

The MiL also performed general chemistry analysis of the four soil and groundwater samples, the results of which will be useful to future bioremediation design efforts. The results of these analyses are presented in Table 2-17.

Table 2-1	
EE/CA SUPPORT SAMPLING ANALYTICAL SUMMARY JENNISON-WRIGHT SITE GRANITE CITY, ILLINOIS	
Sample ID	Analysis
Surface Soil Samples (Grid)	
SS01	PCP, PAH
SS02	PCP, PAH
SS03	PCP, PAH
SS04	PCP, PAH
SS05	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SS06	PCP, PAH
SS07	PCP, PAH
SS08	PCP, PAH
SS10	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SS11	PCP, PAH
SS12	PCP, PAH
SS13	PCP, PAH
SS14	PCP, PAH
SS15 SS97 (CLP duplicate)	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SS16	PCP, PAH
SS17	PCP, PAH
SS18	PCP, PAH
SS19	PCP, PAH
SS20	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SS21	PCP, PAH
SS22	PCP, PAH
SS23	PCP, PAH
SS24	PCP, PAH
SS25	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SS26	PCP, PAH (duplicate)
SS27	PCP, PAH
Surface Soil Samples (Grid) (Cont.)	

Key at end of table.

<p align="center">Table 2-1</p> <p align="center">EE/CA SUPPORT SAMPLING ANALYTICAL SUMMARY</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>	
Sample ID	Analysis
SS28	PCP, PAH
SS29	PCP, PAH
SS30	PCP, PAH (duplicate), VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SS32	PCP, PAH
SS33	PCP, PAH
SS34	PCP, PAH
SS35	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SS36	PCP, PAH
SS37	PCP, PAH (duplicate)
SS38	PCP, PAH
SS39	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SS40	PCP, PAH
SS41	PCP, PAH (duplicate)
SS42	PCP, PAH
SS43	PCP, PAH
SS44	PCP, PAH
SS45	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SS46	PCP, PAH
SS47	PCP, PAH
SS48	PCP, PAH
SS49	PCP, PAH
SS50	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SS51	PCP, PAH
SS52	PCP, PAH
SS53	PCP, PAH
SS55	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SS56	PCP, PAH
Surface Soil Samples (Grid) (Cont.)	
SS57	PCP, PAH

Key at end of table.

<p align="center">Table 2-1</p> <p align="center">EE/CA SUPPORT SAMPLING ANALYTICAL SUMMARY</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>	
Sample ID	Analysis
SS58	PCP, PAH
SS59	PCP, PAH
SS60	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SS61	PCP, PAH
SS62	PCP, PAH
SS63	PCP, PAH
SS64	PCP, PAH (duplicate)
SS65	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SS66	PCP, PAH
SS67	PCP, PAH
SS68	PCP, PAH
SS69	PCP, PAH
SS70 SS98 (CLP duplicate)	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SS71	PCP, PAH
SS72	PCP, PAH
SS73	PCP, PAH
SS74	PCP, PAH
SS75	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SS76	PCP, PAH
SS77	PCP, PAH
SS78	PCP, PAH
SS79	PCP, PAH
SS80	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SS81	PCP, PAH
SS82	PCP, PAH
Surface Soil Samples (Grid) (Cont.)	
SS83	PCP, PAH (duplicate)
SS84	PCP, PAH

Key at end of table.

Table 2-1	
EE/CA SUPPORT SAMPLING ANALYTICAL SUMMARY JENNISON-WRIGHT SITE GRANITE CITY, ILLINOIS	
Sample ID	Analysis
Surface Soil Samples (Biased)	
SS85	VOC, SVOC, Pesticide/PCB, Metals/Cyanide, Dioxins/Furans
SS86	VOC, SVOC, Pesticide/PCB, Metals/Cyanide, Dioxins/Furans
SS87	VOC, SVOC, Pesticide/PCB, Metals/Cyanide, Dioxins/Furans
SS88	VOC, SVOC, Pesticide/PCB, Metals/Cyanide, Dioxins/Furans
SS89	VOC, SVOC, Pesticide/PCB, Metals/Cyanide, Dioxins/Furans, TCLP/Disposal Parameters
SS90 - SS99 (D/F duplicate)	VOC, SVOC, Pesticide/PCB, Metals/Cyanide, Dioxins/Furans
SS91	VOC, SVOC, Pesticide/PCB, Metals/Cyanide, Dioxins/Furans
SS92	VOC, SVOC, Pesticide/PCB, Metals/Cyanide, Dioxins/Furans
SS94	VOC, SVOC, Pesticide/PCB, Metals/Cyanide, Dioxins/Furans
SS95	VOC, SVOC, Pesticide/PCB, Metals/Cyanide, Dioxins/Furans
SS96	VOC, SVOC, Pesticide/PCB, Metals/Cyanide, Dioxins/Furans
SS100	Metals/Cyanide
SS101	Metals/Cyanide
SS102	Metals/Cyanide
SS103	Metals/Cyanide
Subsurface Soil Samples (Geoprobe)	
SB01 (5-6)	PCP, PAH
SB01 (12-13)	PCP, PAH
SB02 (6-7)	PCP, PAH
SB02 (12-13)	PCP, PAH
SB03 (6-7)	PCP, PAH
SB03 (12-13)	PCP, PAH (duplicate)
SB04 (5-7)	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
Subsurface Soil Samples (Geoprobe) (Cont.)	
SB04 (12-13)	PCP, PAH
SB05 (5-6)	PCP, PAH
SB05 (12-13)	PCP, PAH

Key at end of table.

<p style="text-align: center;">Table 2-1</p> <p style="text-align: center;">EE/CA SUPPORT SAMPLING ANALYTICAL SUMMARY</p> <p style="text-align: center;">JENNISON-WRIGHT SITE</p> <p style="text-align: center;">GRANITE CITY, ILLINOIS</p>	
Sample ID	Analysis
SB06 (5-7)	PCP, PAH (duplicate)
SB06 (11-12)	PCP, PAH
SB07 (5-7)	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SB07 (12-13)	PCP, PAH
SB08 (6-8)	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SB08 (11-12)	PCP, PAH
SB09 (5-6)	PCP, PAH
SB09 (12-13)	PCP, PAH
SB11 (6-7)	PCP, PAH
SB11 (12-13)	PCP, PAH
SB12 (5-6)	PCP, PAH
SB12 (12-14)	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SB13 (6-7)	PCP, PAH
SB13 (12-13)	PCP, PAH
SB14 (4-6)	PCP, PAH (duplicate)
SB14 (12-14)	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SB15 (6-7)	PCP, PAH
SB15 (12-13)	PCP, PAH
SB16 (6-7)	PCP, PAH
SB16 (12-13)	PCP, PAH
SB17 (5-7)	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SB17 (11-12)	PCP, PAH
SB18 (5-7) SB31 (5-7) (CLP duplicate)	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
Subsurface Soil Samples (Geoprobe) (Cont.)	
SB18 (11-12)	PCP, PAH
SB19 (5-7)	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SB19 (11-12)	PCP, PAH
SB20 (6-7)	PCP, PAH

Key at end of table.

<p style="text-align: center;">Table 2-1</p> <p style="text-align: center;">EE/CA SUPPORT SAMPLING ANALYTICAL SUMMARY</p> <p style="text-align: center;">JENNISON-WRIGHT SITE</p> <p style="text-align: center;">GRANITE CITY, ILLINOIS</p>	
Sample ID	Analysis
SB20 (10-12)	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SB21 (6-8)	PCP, PAH
SB21 (11-12)	PCP, PAH
SB22 (6-7)	PCP, PAH
SB22 (12-13)	PCP, PAH
SB23 (6-8)	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SB23 (11-12)	PCP, PAH
SB24 (6-7)	PCP, PAH
SB24 (12-13)	PCP, PAH
SB25 (5.5-6.5)	PCP, PAH (duplicate)
SB25 (12-14)	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SB26 (6-8)	PCP, PAH
SB26 (11-12)	PCP, PAH
SB27 (5-6)	PCP, PAH
SB27 (12-13)	PCP, PAH
SB28 (6-7)	PCP, PAH
SB28 (12-14)	PCP, PAH (duplicate)
SB29 (5-7)	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SB29 (12-13)	PCP, PAH
SB30 (6-8)	PCP, PAH
SB30 (11-12)	PCP, PAH
Subsurface Soil Samples (Drill Rig)	
SB31 (12-13)	VOC, SVOC, Pesticide/PCB, Metals/Cyanide
Subsurface Soil Samples (Drill Rig) (Cont.)	
SB32 (6-7)	Biological
SB32 (8-10)	VOC, SVOC, Pesticide/PCB, Metals/Cyanide, TCLP/Disposal Parameters
SB35 (8-10) (CLP duplicate)	VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SB33 (6-8)	VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SB33 (12-13)	Biological

Key at end of table.

<p style="text-align: center;">Table 2-1</p> <p style="text-align: center;">EE/CA SUPPORT SAMPLING ANALYTICAL SUMMARY</p> <p style="text-align: center;">JENNISON-WRIGHT SITE</p> <p style="text-align: center;">GRANITE CITY, ILLINOIS</p>	
Sample ID	Analysis
SB34 (16-17)	VOC, SVOC, Pesticide/PCB, Metals/Cyanide
MW5D-108	Grain Size
MW8S-5	SVOC
MW8S-10	SVOC, pH
MW8S-15	SVOC
MW80S-15 (duplicate)	SVOC
MW8S-20	SVOC, TOC, Grain Size
MW8M-53	Grain Size
MW9S-5	SVOC
MW9S-10	SVOC, pH
MW9S-15	SVOC
MW9S-20	SVOC, TOC, Grain Size
Groundwater Samples (Geoprobe)	
GP01-40	PCP, PAH
GP02-40	PCP, PAH
GP03-40	PCP, PAH (duplicate)
GP04-25	PCP, PAH
GP05-28	PCP, PAH
GP06-24	PCP, PAH
GP07-20	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
GP08-24	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
GP09-24	PCP, PAH
Groundwater Samples (Geoprobe) (Cont.)	
GP11-24	PCP, PAH
GP11-46	PCP, PAH
GP12-24	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
GP13-24	PCP, PAH
GP14-24	PCP, PAH
GP14-40	PCP, PAH

Key at end of table.

<p style="text-align: center;">Table 2-1</p> <p style="text-align: center;">EE/CA SUPPORT SAMPLING ANALYTICAL SUMMARY</p> <p style="text-align: center;">JENNISON-WRIGHT SITE</p> <p style="text-align: center;">GRANITE CITY, ILLINOIS</p>	
Sample ID	Analysis
GP15-24	PCP, PAH
GP16-24	PCP, PAH (duplicate)
GP17-24	PCP, PAH (duplicate)
GP17-40	PCP, PAH
GP18-24 GP31-24 (CLP duplicate)	PCP, PAH, VOC, SVOC, Pesticide/PCB, Metals/Cyanide
GP18-40	PCP, PAH
GP19-24	PCP, PAH
GP20-45	PCP, PAH
GP32-40	PCP, PAH
GP33-40	PCP, PAH
GP34-40	PCP, PAH
GP35-40	PCP, PAH
GP36-24	PCP, PAH
GP36-40	PCP, PAH
GP37-24	PCP, PAH
GP37-40	PCP, PAH
GP38-24	PCP, PAH
GP38-40	PCP, PAH
GP39-40	PCP, PAH
GP40-40	PCP, PAH
Groundwater Samples (Geoprobe) (Cont.)	
GP41-24	PCP, PAH
GP42-24	PCP, PAH
Groundwater Samples (Monitoring Wells)	
MW1S	VOC, SVOC, Pesticide/PCB, Metals/Cyanide
MW1D	VOC, SVOC, Pesticide/PCB, Metals/Cyanide
MW2S	VOC, SVOC, Pesticide/PCB, Metals/Cyanide
MW3S MW30S (CLP duplicate)	VOC, SVOC, Pesticide/PCB, Metals/Cyanide

Key at end of table.

<p style="text-align: center;">Table 2-1</p> <p style="text-align: center;">EE/CA SUPPORT SAMPLING ANALYTICAL SUMMARY</p> <p style="text-align: center;">JENNISON-WRIGHT SITE</p> <p style="text-align: center;">GRANITE CITY, ILLINOIS</p>	
Sample ID	Analysis
MW3D	VOC, SVOC, Pesticide/PCB, Metals/Cyanide
MW4S	VOC, SVOC, Pesticide/PCB, Metals/Cyanide
MW5S	VOC, SVOC, Pesticide/PCB, Metals/Cyanide, TSS, TDS, BOD, COD, Biological
MW5D	VOC, SVOC, Pesticide/PCB, Metals/Cyanide
MW6S	VOC, SVOC, Pesticide/PCB, Metals/Cyanide
MW6M	VOC, SVOC, Pesticide/PCB, Metals/Cyanide
MW6D	VOC, SVOC, Pesticide/PCB, Metals/Cyanide
MW7S	VOC, SVOC, Pesticide/PCB, Metals/Cyanide
MW8S	VOC, SVOC, Pesticide/PCB, Metals/Cyanide, TSS, TDS, BOD
OLD 8S (off site)	PCP, PAH
MW8M MW80M (CLP duplicate)	VOC, SVOC, Pesticide/PCB, Metals/Cyanide
MW8D	VOC, SVOC, Pesticide/PCB, Metals/Cyanide
OLD 8D (off site)	PCP, PAH
MW9S	VOC, SVOC, Pesticide/PCB, Metals/Cyanide
MW9M MW90M (CLP duplicate)	VOC, SVOC, Pesticide/PCB, Metals/Cyanide
MW9D	VOC, SVOC, Pesticide/PCB, Metals/Cyanide
MW10S	VOC, SVOC, Pesticide/PCB, Metals/Cyanide, Biological
Groundwater Samples (Monitoring Wells) (Cont.)	
OLD 10D (off site)	PCP
MW11S	VOC, SVOC, Pesticide/PCB, Metals/Cyanide
MW11M	VOC, SVOC, Pesticide/PCB, Metals/Cyanide
Sediment Samples	
SD01	VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SD02	VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SD03	VOC, SVOC, Pesticide/PCB, Metals/Cyanide
SD04	VOC, SVOC, Pesticide/PCB, Metals/Cyanide, TCLP/Disposal Parameters
SD05 (CLP duplicate)	VOC, SVOC, Pesticide/PCB, Metals/Cyanide

Key at end of table.

Table 2-1	
EE/CA SUPPORT SAMPLING ANALYTICAL SUMMARY JENNISON-WRIGHT SITE GRANITE CITY, ILLINOIS	
Sample ID	Analysis
Building Material Samples	
OB01	Asbestos
OB02	Asbestos
BB03	Asbestos
GB04	Asbestos
BB05	Asbestos
BB06	Asbestos
TB07	Asbestos
TB08	Asbestos
WB09	Asbestos
WB10	Asbestos
WB11	Asbestos
PB12	Asbestos
WB13	Asbestos
BB14	Asbestos

Note: All grid surface soil samples, all Geoprobe subsurface soil samples, and Geoprobe groundwater samples GP01 through GP20 were analyzed for PCP at the on-site field laboratory using an immunoassay screening method (EPA Method 4010). Geoprobe groundwater samples GP32 through GP42 and monitoring well groundwater samples OLD 8S, OLD 8D, and OLD 10D were analyzed for PCP at E & E's ASC using a single-column screening method (EPA Method 8270).

Table 2-1 (Cont.)

Key:

BOD = Biochemical oxygen demand.
 CLP = Contract Laboratory Program.
 COD = Chemical oxygen demand.
 D/F = Dioxins/Furans.
 EE/CA = Engineering evaluation/cost analysis.
 ID = Inside diameter.
 PAH = Polynuclear aromatic hydrocarbon.
 PCB = Polychlorinated biphenyl.
 PCP = Pentachlorophenol.
 SVOC = Semivolatile organic compound.
 TCLP = Toxicity characteristic leaching procedure.
 TDS = Total dissolved solids.
 TSS = Total suspended solids.
 TOC = Total organic carbon.

VOC = Volatile organic compound.

<p align="center">Table 2-2</p> <p align="center">GROUNDWATER ELEVATION DATA—SEPTEMBER 5, 1997</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>				
Monitoring Well	Ground Surface Elevation (ft. above MSL)	Top of Inside Casing Elevation (ft. above MSL)	Depth to Water (ft. below TOIC)	Groundwater Elevation (ft. above MSL)
MW1S	422.06	424.57	20.08	404.49
MW1D	421.92	423.88	19.42	404.46
MW2S	416.81	419.15	14.62	404.53
MW3S	419.74	422.11	18.11	404.00
MW3D	420.26	422.42	18.40	404.02
MW4S	422.03	421.29	17.52	403.77
MW5S	422.16	424.64	20.61	404.03
MW5D	421.39	423.18	19.15	404.03
MW6S	420.94	420.57	16.72	403.85
MW6M	421.05	422.90	19.06	403.84
MW6D	421.12	422.70	18.85	403.85
MW7S	421.82	421.25	17.49	403.76
MW8S	422.51	424.50	20.93	403.57
MW8M	421.40	423.38	19.74	403.64
MW8D	422.72	424.65	21.08	403.57
MW9S	422.36	424.76	20.92	403.84
MW9M	422.39	424.56	21.01	403.55
MW9D	422.27	424.44	20.83	403.61
MW10S	421.63	424.05	20.70	403.35
MW11S	422.22	425.33	22.12	403.21
MW11M	422.86	424.96	21.69	403.27

Key:

MSL = Mean Sea Level.

TOIC = Top of Inside Casing.

<p align="center">Table 2-3</p> <p align="center">GROUNDWATER ELEVATION DATA—DECEMBER 11, 1997</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>				
Monitoring Well	Ground Surface Elevation (ft. above MSL)	Top of Inside Casing Elevation (ft. above MSL)	Depth to Water (ft. below TOIC)	Groundwater Elevation (ft. above MSL)
MW1S	422.06	424.57	21.60	402.97
MW1D	421.92	423.88	20.94	402.94
MW2S	416.81	419.15	16.10	403.05
MW3S	419.74	422.11	19.55	402.56
MW3D	420.26	422.42	19.84	402.58
MW4S	422.03	421.29	18.94	402.35
MW5S	422.16	424.64	22.05	402.59
MW5D	421.39	423.18	20.58	402.60
MW6S	420.94	420.57	18.13	402.44
MW6M	421.05	422.90	20.47	402.43
MW6D	421.12	422.70	20.27	402.43
MW7S	421.82	421.25	18.91	402.34
MW8S	422.51	424.50	22.33	402.17
MW8M	421.40	423.38	21.15	402.23
MW8D	422.72	424.65	22.47	402.18
MW9S	422.36	424.76	22.49	402.27
MW9M	422.39	424.56	22.40	402.16
MW9D	422.27	424.44	22.23	402.21
MW10S	421.63	424.05	22.08	401.97
MW11S	422.22	425.33	23.47	401.86
MW11M	422.86	424.96	23.07	401.89

Key:

MSL = Mean Sea Level.

TOIC = Top of Inside Casing.

<p align="center">Table 2-4</p> <p align="center">FREQUENCY OF PCP IMMUNOASSAY SCREENING CONCENTRATIONS</p> <p align="center">GRIDDED SURFACE AND SUBSURFACE SOIL SAMPLES</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>					
Sample Matrix	<0.5 ppm	>0.5 ppm and <5.0 ppm	>5.0 ppm and <50 ppm	>50 ppm	Locations >50 ppm
Surface soil (grid)	26/81	41/81	10/81	4/81	SS01, SS05, SS06, SS22
Subsurface soil	54/58	2/58	0/58	2/58	SB03 (12-13), SB16 (6-7)

Key:

< = Less than.
 > = Greater than.
 ppm = Parts per million.

<p align="center">Table 2-5</p> <p align="center">SUMMARY OF CONTAMINANT CONCENTRATIONS</p> <p align="center">GRIDDED SURFACE SOIL SAMPLES</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>				
Contaminant	Minimum Detected Concentration	Maximum Detected Concentration	Location(s) of Maximum Concentration	Frequency of Detection
PAH Screening Results (µg/g)				
Naphthalene	33	100	SS05	5/81
Acenaphthylene	15	610 X	SS17	15/81
1-Methylnaphthalene	16	3,100 X	SS17	23/81
2-Methylnaphthalene	13.5	1,900 X	SS17	14/81
Acenaphthene	11	2,000 X	SS11	29/81
Fluorene	0.7	800 X	SS11	35/81
Phenanthrene	1.3	680 X	SS11	51/81
Anthracene	1.0	150 X	SS11	28/81
Fluoranthene	3.8	3,100 X	SS17	67/81
Pyrene	3.4	2,800 X	SS17	64/81
Benzo(a)anthracene	1.5	1,200 X	SS11	65/81
Chrysene	1.7	1,100 X	SS11, SS17	74/81
Benzo(b)fluoranthene	3.2	630 X	SS17	76/81
Benzo(k)fluoranthene	1.3	410 X	SS11, SS17	75/81
Benzo(a)pyrene	1.4	400 X	SS11	76/81
Dibenzo(a,h)anthracene	3.2	130 X	SS40	44/81
Benzo(ghi)perylene	1.4	260	SS72	69/81
Indeno(1,2,3-cd)pyrene	1.4	120 X	SS22, SS24	73/81
CLP Laboratory Results:				
VOC (µg/kg)				
Methylene chloride	1 J	5 J	SS10	10/16
Acetone	NA	7 J	SS05	1/16
Carbon disulfide	NA	2 J	SS05	1/16
Benzene	NA	2 J	SS05	1/16

Key at end of table.

<p align="center">Table 2-5</p> <p align="center">SUMMARY OF CONTAMINANT CONCENTRATIONS</p> <p align="center">GRIDDED SURFACE SOIL SAMPLES</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>				
Contaminant	Minimum Detected Concentration	Maximum Detected Concentration	Location(s) of Maximum Concentration	Frequency of Detection
CLP Laboratory Results (Cont.)				
VOC (µg/kg) (Cont.)				
Toluene	5 J	69 J	SS80	15/16
Ethylbenzene	NA	2 J	SS05	1/16
Xylene (total)	2 J	97 J	SS05	3/16
SVOC (µg/kg)				
Phenol	NA	330 J	SS39	1/16
4-Methylphenol	88 J	2,200 J	SS05	4/16
2,4-Dimethylphenol	54 J	4,700 J	SS05	4/16
Naphthalene	76 J	70,000	SS05	9/16
2-Methylnaphthalene	61 J	55,000	SS05	9/16
Acenaphthylene	120 J	87,000	SS05	16/16
Acenaphthene	38 J	35,000	SS15	11/16
Dibenzofuran	32 J	32,000 J	SS05	12/16
Fluorene	19 J	69,000 J	SS05	10/16
Pentachlorophenol	NA	3,200 J	SS15	1/16
Phenanthrene	55 J	400,000	SS05	16/16
Anthracene	120 J	120,000	SS39	16/16
Carbazole	83 J	42,000 J	SS05	14/16
Fluoranthene	130 J	280,000	SS15	15/16
Pyrene	130 J	310,000	SS05	16/16
Butylbenzylphthalate	NA	75 J	SS60	1/16
Benzo(a)anthracene	73 J	120,000	SS05	16/16
Chrysene	120 J	140,000	SS10	15/16
Benzo(b)fluoranthene	130 J	220,000	SS10	16/16

Key at end of table.

<p align="center">Table 2-5</p> <p align="center">SUMMARY OF CONTAMINANT CONCENTRATIONS</p> <p align="center">GRIDDED SURFACE SOIL SAMPLES</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>				
Contaminant	Minimum Detected Concentration	Maximum Detected Concentration	Location(s) of Maximum Concentration	Frequency of Detection
CLP Laboratory Results (Cont.)				
SVOC (µg/kg) (Cont.)				
Benzo(k)fluoranthene	110 J	180,000	SS05	15/16
Benzo(a)pyrene	94 J	120,000	SS10	16/16
Indeno(1,2,3-cd)pyrene	88 J	240,000	SS05	16/16
Dibenzo(a,h)anthracene	150 J	110,000	SS05	16/16
Benzo(g,h,i)perylene	100 J	210,000	SS05	16/16
Pesticide/PCB (µg/kg)				
beta-BHC	3 J	21 J	SS05	2/16
delta-BHC	2.3 J	18	SS05	3/16
gamma-BHC (Lindane)	NA	2.6 J	SS75	1/16
Heptachlor	NA	3 J	SS75	1/16
Aldrin	2.7 J	61 J	SS05	2/16
Heptachlor epoxide	2 J	29 J	SS15	6/16
Endosulfan I	2.4 J	17 J	SS30	4/16
Dieldrin	4 J	47 J	SS80	11/16
4,4'-DDE	19 J	36 J	SS75	3/16
Endrin	9.8 J	110	SS60	11/16
Endosulfan II	4.2 J	46 J	SS25	9/16
4,4'-DDD	6.1 J	61	SS50	8/16
Endosulfan sulfate	7.6 J	190	SS05	4/16
4,4'-DDT	7.8 J	300 J	SS80	10/16
Methoxychlor	32 J	660	SS35	5/16
Endrin ketone	3.6 J	260 J	SS05	11/16
Endrin aldehyde	3.8 J	310	SS60	10/16

Key at end of table.

<p align="center">Table 2-5</p> <p align="center">SUMMARY OF CONTAMINANT CONCENTRATIONS</p> <p align="center">GRIDDED SURFACE SOIL SAMPLES</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>				
Contaminant	Minimum Detected Concentration	Maximum Detected Concentration	Location(s) of Maximum Concentration	Frequency of Detection
CLP Laboratory Results (Cont.)				
Pesticide/PCB (µg/kg) (Cont.)				
alpha-Chlordane	3.9 J	120 J	SS65	4/16
gamma-Chlordane	2.5 J	226 J	SS15	7/16
Inorganic (mg/kg)				
Aluminum	5,210	26,100	SS45	16/16
Antimony	0.4 J	9.5	SS80	12/16
Arsenic	2.9	15	SS10	15/16
Barium	107	256	SS25	16/16
Beryllium	0.4 J	5.2	SS45	16/16
Cadmium	0.5	5.1	SS25	12/16
Calcium	2,570	177,000	SS45	16/16
Chromium	9.6	1,270	SS55	16/16
Cobalt	1.5	6.9	SS80	16/16
Copper	11.5	168	SS60	16/16
Iron	11,700	132,000	SS55	16/16
Lead	25	320	SS80	16/16
Magnesium	1,700	46,000	SS45	16/16
Manganese	294	24,700	SS20	16/16
Mercury	0.06	0.2	SS80	5/16
Nickel	5.4	26.9	SS50	16/16
Potassium	587 J	2,660	SS45	16/16
Selenium	0.9 J	2.2 J	SS05	6/16
Silver	0.2 J	1.0 J	SS55	9/16
Sodium	212	2,200	SS35	16/16

Key at end of table.

<p style="text-align: center;">Table 2-5</p> <p style="text-align: center;">SUMMARY OF CONTAMINANT CONCENTRATIONS</p> <p style="text-align: center;">GRIDDED SURFACE SOIL SAMPLES</p> <p style="text-align: center;">JENNISON-WRIGHT SITE</p> <p style="text-align: center;">GRANITE CITY, ILLINOIS</p>				
Contaminant	Minimum Detected Concentration	Maximum Detected Concentration	Location(s) of Maximum Concentration	Frequency of Detection
CLP Laboratory Results (Cont.)				
Inorganic (mg/kg) (Cont.)				
Thallium	0.9	3.1	SS25	14/16
Vanadium	16	656	SS55	16/16
Zinc	75.5	863	SS80	16/16
Cyanide	0.2 J	9.7 J	SS15	16/16

Note: This table reports only organics and inorganics that were detected in the analysis. The total number of samples does not include duplicate samples. Results of PAH screening investigative samples SS26, SS30, SS37, SS41, SS52, SS64, and SS83, and CLP investigative samples SS15 and SS70 were averaged with the results of the duplicate samples to obtain a concentration representative of the location.

Key:

CLP = Contract Laboratory Program.
J = Value is estimated.
µg/g = Micrograms per gram (parts per million).
µg/kg = Micrograms per kilogram (parts per billion).
mg/kg = Milligrams per kilogram (parts per million).
NA = Not applicable.
PAH = Polynuclear aromatic hydrocarbon.
PCB = Polychlorinated biphenyl.
SVOC = Semivolatile organic compound.
VOC = Volatile Organic Compound.
X = Exceeds calibration limits. Result is usable.

Table 2-6

**PAH COMPOUNDS DETECTED IN GRIDDED
SURFACE SOIL SAMPLES
JENNISON-WRIGHT SITE
GRANITE CITY, ILLINOIS**

Naphthalene	Benzo(a)anthracene
2-Methylnaphthalene	Chrysene
Acenaphthylene	Benzo(b)fluoranthene
Acenaphthene	Benzo(k)fluoranthene
Fluorene	Benzo(a)pyrene
Phenanthrene	Indeno(1,2,3-cd)pyrene
Anthracene	Dibenzo(a,h)anthracene
Fluoranthene	Benzo(g,h,i)perylene
Pyrene	

<p align="center">Table 2-7</p> <p align="center">SUMMARY OF CONTAMINANT CONCENTRATIONS</p> <p align="center">BIASED SURFACE SOIL SAMPLES</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>				
Contaminant	Minimum Detected Concentration	Maximum Detected Concentration	Location(s) of Maximum Concentration	Frequency of Detection
CLP Laboratory Results				
VOC (µg/kg)				
Chloromethane	NA	4 J	SS95	1/11
Methylene chloride	1 J	2 J	SS85, SS87, SS88	6/11
Acetone	5 J	9 J	SS95	3/11
Carbon disulfide	NA	1 J	SS88	1/11
2-Butanone	NA	1 J	SS95	1/11
Toluene	1 J	880 J	SS89	8/11
Ethylbenzene	1 J	1,000 J	SS89	2/11
Styrene	1 J	860 J	SS89	3/11
Xylene (total)	5 J	3,000	SS89	2/11
SVOC (µg/kg)				
2-Methylphenol	NA	21 J	SS90	1/11
4-Methylphenol	NA	85 J	SS90	1/11
2,4-Dimethylphenol	NA	75 J	SS90	1/11
Naphthalene	220 J	3,300,000 J	SS89	10/11
2-Methylnaphthalene	52 J	4,600,000	SS89	11/11
Acenaphthylene	1,300	270,000 J	SS89	10/11
Acenaphthene	94 J	10,000,000	SS89	8/11
Dibenzofuran	120 J	8,800,000	SS89	11/11
Fluorene	160 J	14,000,000	SS89	10/11
Pentachlorophenol	3,600 J	520,000	SS95	6/11
Phenanthrene	720	62,000,000	SS89	11/11
Anthracene	2,800	12,000,000	SS89	11/11
Carbazole	570 J	5,600,000 J	SS88	10/11
Di-n-butylphthalate	NA	2,800 J	SS91	1/11
CLP Laboratory Results (Cont.)				

Key at end of table.

<p align="center">Table 2-7</p> <p align="center">SUMMARY OF CONTAMINANT CONCENTRATIONS</p> <p align="center">BIASED SURFACE SOIL SAMPLES</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>				
Contaminant	Minimum Detected Concentration	Maximum Detected Concentration	Location(s) of Maximum Concentration	Frequency of Detection
SVOC (µg/kg) (Cont.)				
Fluoranthene	1,800	39,000,000 J	SS88	11/11
Pyrene	2,300	27,000,000 J	SS88	11/11
Benzo(a)anthracene	2,500	7,000,000 J	SS88	11/11
Chrysene	5,100	7,400,000 J	SS88	11/11
Bis(2-ethylhexyl)phthalate	NA	3,400 J	SS95	1/11
Benzo(b)fluoranthene	4,100	2,900,000 J	SS88	11/11
Benzo(k)fluoranthene	3,800	3,100,000 J	SS88	11/11
Benzo(a)pyrene	3,500 J	2,800,000 J	SS88	11/11
Indeno(1,2,3-cd)pyrene	3,700	930,000 J	SS88	11/11
Dibenzo(a,h)anthracene	1,400	350,000 J	SS88	10/11
Benzo(g,h,i)perylene	4,000	800,000 J	SS88	11/11
Pesticide/PCB (µg/kg)				
alpha-BHC	3.2 J	24 J	SS95	5/11
beta-BHC	NA	3.3 J	SS88	1/11
delta-BHC	25 J	88 J	SS89	2/11
gamma-BHC (Lindane)	NA	3.1 J	SS90	1/11
Heptachlor	2 J	7.4 J	SS89	4/11
Aldrin	2.2 J	34 J	SS89	6/11
Heptachlor epoxide	3.4 J	33	SS95	7/11
Endosulfan I	1.9 J	19 J	SS91	4/11
Dieldrin	4.5 J	220 J	SS92	5/11
Endrin	3.6 J	1,000 J	SS95	10/11
Endosulfan II	4.8 J	120 J	SS88	8/11
4,4'-DDD	4.8 J	880 J	SS89	7/11
CLP Laboratory Results (Cont.)				
Pesticide/PCB (µg/kg) (Cont.)				

Key at end of table.

<p align="center">Table 2-7</p> <p align="center">SUMMARY OF CONTAMINANT CONCENTRATIONS</p> <p align="center">BIASED SURFACE SOIL SAMPLES</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>				
Contaminant	Minimum Detected Concentration	Maximum Detected Concentration	Location(s) of Maximum Concentration	Frequency of Detection
Endosulfan sulfate	16 J	100 J	SS88	3/11
4,4'-DDT	5.5 J	320 J	SS95	8/11
Methoxychlor	NA	480 J	SS95	1/11
Endrin ketone	10 J	280	SS95	11/11
Endrin aldehyde	6 J	180 J	SS95	2/11
Inorganic (mg/kg)				
Aluminum	4,690	20,800	SS96	11/11
Antimony	0.5	6.6	SS91	11/11
Arsenic	3.1	11	SS85	11/11
Barium	76.2	236	SS96	11/11
Beryllium	0.4 J	3.9	SS96	10/11
Cadmium	0.5	2.8	SS96	10/11
Calcium	8,920	118,000	SS88	11/11
Chromium	14.8	219	SS96	11/11
Cobalt	1.8	8.2	SS85	11/11
Copper	15.7	139	SS85	11/11
Iron	15,000	40,300	SS96	11/11
Lead	13	581	SS91	11/11
Magnesium	2,030	33,300	SS96	11/11
Manganese	381	5,830 J	SS96	11/11
Mercury	0.08	0.4	SS85	9/11
Nickel	6.4	28.4	SS95	11/11
Potassium	500 J	2,280 J	SS96	11/11

Key at end of table.

<p align="center">Table 2-7</p> <p align="center">SUMMARY OF CONTAMINANT CONCENTRATIONS</p> <p align="center">BIASED SURFACE SOIL SAMPLES</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>				
Contaminant	Minimum Detected Concentration	Maximum Detected Concentration	Location(s) of Maximum Concentration	Frequency of Detection
CLP Laboratory Results (Cont.)				
Inorganic (mg/kg) (Cont.)				
Selenium	1.1	4.5 J	SS89	5/11
Silver	0.3 J	0.4 J	SS85	4/11
Sodium	258	1,850	SS88	11/11
Thallium	0.6	2.9	SS96	7/11
Vanadium	20.7	325	SS96	11/11
Zinc	60.3	1,340	SS95	11/11
Cyanide	0.4 J	4.7	SS88	10/11
Dioxin/Furan (µg/kg)				
123478-HxCDF	NA	4.0612 J	SS95	1/11
123678-HxCDF	NA	1.9918 J	SS95	1/11
123478-HxCDD	1.0959 J	9.6994	SS95	2/11
123678-HxCDD	0.8244 J	49.2682	SS95	6/11
123789-HxCDD	2.1644 J	20.6418	SS95	2/11
234678-HxCDF	NA	6.8679	SS95	1/11
1234678-HpCDD	3.8078 J	2,260.892 E	SS95	11/11
1234678-HpCDF	4.1462 J	246.2231	SS95	8/11
1234789-HpCDF	1.233 J	28.9293	SS95	5/11
OCDD	80.2327 B	29,573.46 EB	SS95	11/11
OCDF	1.0872 J	2,208.857 E	SS95	11/11

Note: This table reports only the organics and inorganics that were detected in the analysis. Total number of samples does not include duplicate samples. Results of CLP investigative sample SS90 were averaged with the results of the duplicate sample to obtain a concentration representative of the location.

Key at end of table.

Table 2-7 (Cont.)

Key:

B	= Compound is also present in associated blank.
CLP	= Contract Laboratory Program.
E	= Concentration exceeds calibration range of the instrument.
J	= Value is estimated.
µg/kg	= Micrograms per kilogram.
mg/kg	= Milligrams per kilogram.
NA	= Not applicable.
PCB	= Polychlorinated biphenyl.
SVOC	= Semivolatile organic compound.
VOC	= Volatile organic compound.

<p>Table 2-8</p> <p>DIOXIN TOXICITY EQUIVALENCE SUMMARY</p> <p>JENNISON-WRIGHT SITE</p> <p>GRANITE CITY, ILLINOIS</p>	
Field Sample Identification	TEF-Adjusted Concentration (µg/kg)
SS85	9.3591
SS86	26.9764
SS87	0.2617
SS88	6.8388
SS89	3.2171
SS90	0.1194
SS99	0.2120
SS91	19.7078
SS92	2.0700
SS94	12.4439
SS95	66.3958
SS96	22.5252

Note: Sample SS99 was a duplicate sample of SS90.

Key:

TEF = 2,3,7,8-TCDD Toxicity Equivalency Factor.
µg/kg = Micrograms per kilogram.

<p align="center">Table 2-9</p> <p align="center">TCLP/DISPOSAL PARAMETER RESULTS</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>				
Parameter (units)	Surface Soil SS89	Sediment SD04	Subsurface Soil SB32 (8-10)	Regulatory Level
Sulfide-reactive (mg/kg)	ND	ND	ND	
Cyanide-reactive (mg/kg)	ND	ND	ND	
Ignitability of solids (yes or no)	No	No	No	
Btu (Btu/lb)	8,800	ND	ND	
Paint filter (pass or fail)	Pass	Fail	Pass	
Ash (%)	36	14	82	
TCLP Pyridine (µg/L)	ND	ND	18J	5,000
TCLP Barium (mg/L)	0.18B	0.91B	0.53B	100
TCLP Cadmium (mg/L)	0.0015B	ND	ND	1.0
TCLP Chromium (mg/L)	0.0053B	ND	0.0058B	5.0
TCLP Lead (mg/L)	0.02B	0.048B	ND	5.0
TCLP Selenium (mg/L)	ND	ND	0.049B	1.0

Note: For the TCLP analyses, only detected compounds are shown on this table.

Key:

ND = Non-detect.
 TCLP = Toxicity characteristic leaching procedure.
 Btu/lb = British thermal unit per pound.
 B = Compound is also present in associated blank.
 J = Value is estimated.
 mg/kg = Milligrams per kilogram.
 µg/L = Micrograms per liter.
 mg/L = Milligrams per liter.

<p align="center">Table 2-10</p> <p align="center">SUMMARY OF CONTAMINANT CONCENTRATIONS</p> <p align="center">OFF-SITE SURFACE SOIL SAMPLES</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>				
Contaminant	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Location(s) of Maximum Concentration	Frequency of Detection
ASC Laboratory Results				
Inorganic				
Aluminum	6,500	8,700	SS100	4/4
Arsenic	7.3	8.2	SS103	4/4
Barium	92	460	SS103	4/4
Cadmium	1.1	1.1	SS102, SS103	2/4
Calcium	7,700	39,000	SS101	4/4
Chromium	13	15	SS100, SS102	4/4
Cobalt	6.1	6.8	SS100	4/4
Copper	15	31	SS100	4/4
Iron	14,000	16,000	SS102	4/4
Lead	12	58	SS103	4/4
Magnesium	4,500	21,000	SS101	4/4
Manganese	500	550	SS100, SS103	4/4
Mercury	0.02	0.02	SS100, SS102	2/4
Nickel	14	18	SS100	4/4
Potassium	1,200	2,200	SS100	4/4
Selenium	0.81	3.5	SS103	4/4
Sodium	140	1,200	SS101	3/4
Thallium	0.78	1.9	SS101	4/4
Vanadium	22	30	SS100	4/4
Zinc	55	220	SS102, SS103	4/4

Key:

mg/kg = Milligrams per kilogram.

<p align="center">Table 2-11</p> <p align="center">SUMMARY OF CONTAMINANT CONCENTRATIONS</p> <p align="center">SUBSURFACE SOIL SAMPLES</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>				
Contaminant	Minimum Detected Concentration	Maximum Detected Concentration	Location(s) of Maximum Concentration	Frequency of Detection
PAH Screening Results (µg/g)				
Naphthalene	70	6,700 X	SB26 (11-12)	8/58
Acenaphthylene	22	100	SB03 (12-13)	4/58
1-Methylnaphthalene	82	2,900 X	SB26 (11-12)	8/58
2-Methylnaphthalene	130	3,100 X	SB26 (11-12)	7/58
Acenaphthene	39	1,300 X	SB26 (11-12)	7/58
Fluorene	1 J	500,000	SB27 (5-6)	8/58
Phenanthrene	1.6	720 X	SB26 (11-12)	11/58
Anthracene	5.6	190 X	SB26 (11-12)	8/58
Fluoranthene	3.5	1,600 X	SB26 (11-12)	11/58
Pyrene	2.6	880 X	SB26 (11-12)	10/58
Benzo(a)anthracene	1.1	270 X	SB26 (11-12)	11/58
Chrysene	1 J	290 X	SB26 (11-12)	11/58
Benzo(b)fluoranthene	0.84 J	130 X	SB26 (11-12)	10/58
Benzo(k)fluoranthene	0.46 J	72 X	SB26 (11-12)	9/58
Benzo(a)pyrene	1 J	100 X	SB26 (11-12)	11/58
Dibenzo(a,h)anthracene	4	25	SB26 (11-12)	5/58
Benzo(ghi)perylene	1.2 J	28	SB26 (11-12)	6/58
Indeno(1,2,3-cd)pyrene	0.37 J	700,000	SB26 (11-12)	9/58
CLP Laboratory Results				
VOC (µg/kg)				
Chloromethane	2 J	3 J	SB08 (6-8)	3/16
Methylene chloride	1 J	8 J	SB04 (5-7)	6/16
Acetone	3 J	4 J	SB19 (5-7)	2/16
Chloroform	NA	1 J	SB31 (5-7)	1/16
Benzene	NA	4,050	SB32 (8-10)	1/16
CLP Laboratory Results (Cont.)				

Key at end of table.

<p align="center">Table 2-11</p> <p align="center">SUMMARY OF CONTAMINANT CONCENTRATIONS</p> <p align="center">SUBSURFACE SOIL SAMPLES</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>				
Contaminant	Minimum Detected Concentration	Maximum Detected Concentration	Location(s) of Maximum Concentration	Frequency of Detection
VOC (µg/kg) (Cont.)				
2-Hexanone	NA	10 J	SB14 (12-14)	1/16
Toluene	2 J	11,500	SB32 (8-10)	8/16
Chlorobenzene	NA	2 J	SB19 (5-7)	1/16
Ethylbenzene	1,400 J	7,350	SB32 (8-10)	2/16
Styrene	NA	4,450	SB32 (8-10)	1/16
Xylene (total)	2,700	30,500	SB32 (8-10)	2/16
SVOC (µg/kg)				
Phenol	NA	7,700	SB32 (8-10)	1/24
2-Methylphenol	NA	11,000 J	SB32 (8-10)	1/24
4-Methylphenol	NA	35,000	SB32 (8-10)	1/24
2,4-Dimethylphenol	NA	24,500 J	SB32 (8-10)	1/24
Naphthalene	61 J	190,000	SB33 (6-8)	10/24
2-Methylnaphthalene	55 J	56,000	SB33 (6-8)	5/24
Acenaphthylene	22 J	50,000	SB32 (8-10)	4/24
Acenaphthene	39 J	89,000	SB33 (6-8)	6/24
Dibenzofuran	41 J	68,000	SB33 (6-8)	6/24
Fluorene	38 J	97,000	SB33 (6-8)	6/24
Pentachlorophenol	24 J	61,500	SB32 (8-10)	3/24
Phenanthrene	37 J	280,000	SB33 (6-8)	13/24
Anthracene	44 J	220,000	SB32 (8-10)	7/24
Carbazole	40 J	100,000	SB32 (8-10)	4/24
Di-n-butylphthalate	27 J	160 J	SB04 (5-7)	3/24
Fluoranthene	26 J	240,000	SB32 (8-10)	10/24
Pyrene	21 J	800	SB14 (12-14)	8/24
CLP Laboratory Results (Cont.)				
SVOC (µg/kg) (Cont.)				

Key at end of table.

<p align="center">Table 2-11</p> <p align="center">SUMMARY OF CONTAMINANT CONCENTRATIONS</p> <p align="center">SUBSURFACE SOIL SAMPLES</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>				
Contaminant	Minimum Detected Concentration	Maximum Detected Concentration	Location(s) of Maximum Concentration	Frequency of Detection
Benzo(a)anthracene	23 J	215,000	SB32 (8-10)	7/24
Chrysene	31 J	165,000	SB32 (8-10)	8/24
Bis(2-ethylhexyl)phthalate	NA	73 J	SB12 (12-14)	1/24
Benzo(b)fluoranthene	43 J	125,000	SB32 (8-10)	8/24
Benzo(k)fluoranthene	95 J	44,500	SB32 (8-10)	5/24
Benzo(a)pyrene	22 J	96,500	SB32 (8-10)	6/24
Indeno(1,2,3-cd)pyrene	30 J	37,000	SB32 (8-10)	6/24
Dibenzo(a,h)anthracene	32 J	6,300 J	SB33 (6-8)	5/24
Benzo(g,h,i)perylene	34 J	35,000	SB32 (8-10)	7/24
Pesticide/PCB (µg/kg)				
Endosulfan I	NA	2.5	SB33 (6-8)	1/16
Dieldrin	7.4 J	200 J	SB07 (5-7)	3/16
4,4'-DDE	NA	2.1 J	SB32 (8-10)	1/16
Endrin	NA	26 J	SB04 (5-7)	1/16
4,4'-DDD	NA	44 J	SB20 (10-12)	1/16
Methoxychlor	22 J	390 J	SB07 (5-7)	2/16
Endrin ketone	9.1 J	180 J	SB04 (5-7)	3/16
gamma-Chlordane	4 J	5.5 J	SB07 (5-7)	3/16
Inorganic (mg/kg)				
Aluminum	2,480	15,100	SB33 (6-8)	16/16
Antimony	0.5 J	0.8 J	SB19 (5-7)	4/16
Arsenic	2.4	8.0	SB19 (5-7)	16/16
Barium	28.9	199	SB33 (6-8)	11/16
Beryllium	0.3	0.7	SB33 (6-8)	5/16
CLP Laboratory Results (Cont.)				
Inorganic (mg/kg) (Cont.)				
Calcium	1,040	17,000	SB34 (16-17)	16/16
Chromium	4.5 J	20.3	SB33 (6-8)	16/16

<p align="center">Table 2-11</p> <p align="center">SUMMARY OF CONTAMINANT CONCENTRATIONS</p> <p align="center">SUBSURFACE SOIL SAMPLES</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>				
Contaminant	Minimum Detected Concentration	Maximum Detected Concentration	Location(s) of Maximum Concentration	Frequency of Detection
Cobalt	3.2	8.4	SB33 (6-8)	11/16
Copper	1.4	20.3	SB33 (6-8)	15/16
Iron	5,560	19,400	SB33 (6-8)	16/16
Lead	3.6	13.8	SB19 (5-7)	16/16
Magnesium	1,160	6,390	SB34 (16-17)	16/16
Manganese	64.3	464	SB07 (5-7)	16/16
Nickel	8.1	22.1	SB33 (6-8)	16/16
Potassium	443	2,480	SB33 (6-8)	13/16
Sodium	46.9	310	SB19 (5-7)	11/16
Thallium	0.7 J	2.9	SB07 (5-7)	11/16
Vanadium	7.8	35.6	SB33 (6-8)	16/16
Zinc	17.9	140	SB33 (6-8)	16/16
Cyanide	NA	0.1 J	SB20 (10-12) SB29 (5-7)	2/16

Note: This table reports only organics and inorganics that were detected in the analysis. Total number of samples does not include duplicate samples. Results of PAH screening investigative samples SB03 (12-13), SB06 (5-7), SB14 (4-6), SB16 (6-7), SB25 (5.5-6.5), and SB28 (12-14), and CLP investigative samples SB32 (8-10), SB18 (5-7), and MW8S-15 were averaged with the results of the duplicate sample to obtain a concentration representative of the location.

Key:

CLP = Contract Laboratory Program.
J = Value is estimated.
µg/g = Micrograms per gram.
µg/kg = Micrograms per kilogram.
mg/kg = Milligrams per kilogram.
NA = Not applicable.
PAH = Polynuclear aromatic hydrocarbon.
PCB = Polychlorinated biphenyl.
SVOC = Semivolatile organic compound.
VOC = Volatile organic compound.
X = Exceeds calibration range of instrument. Result is usable.

<p align="center">Table 2-12</p> <p align="center">FREQUENCY OF PCP IMMUNOASSAY SCREENING CONCENTRATIONS</p> <p align="center">GEOPROBE GROUNDWATER SAMPLES</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>					
Sample Matrix	<5.0 ppb	>5.0 ppb and <50 ppb	>50 ppb and <100 ppb	>100 ppb	Locations >100 ppb
Geoprobe Groundwater	8/23	6/23	1/23	8/23	GP01-40, GP08-24, GP11-24, GP11-46, GP13-24, GP16-24, GP17-40, GP18-40

Note: The total number of samples (23) represents the Geoprobe groundwater samples collected in July and August 1997, and analyzed at the on-site field laboratory using an immunoassay screening method for PCP (EPA Method 4010).

Key:

< = Less than.
 > = Greater than.
 ppb = parts per billion.
 PCP = Pentachlorophenol.

<p align="center">Table 2-13</p> <p align="center">SUMMARY OF CONTAMINANT CONCENTRATIONS</p> <p align="center">GEOPROBE GROUNDWATER SAMPLES</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>				
Contaminant	Minimum Detected Concentration	Maximum Detected Concentration	Location(s) of Maximum Concentration	Frequency of Detection
PAH and PCP Screening Results (µg/L)				
Naphthalene	22	2,600 X	GP01-40, GP38-24	5/37
Acenaphthylene	NA	100	GP08-24	1/37
1-Methylnaphthalene	12	570X	GP38-24	4/37
2-Methylnaphthalene	NA	470X	GP38-24	2/37
Acenaphthene	25	330X	GP38-24	3/37
Fluorene	2.3	81 X	GP38-24	4/37
Phenanthrene	4.7	160 X	GP01-40	3/37
Anthracene	NA	3.6	GP38-24	1/37
Fluoranthene	10	530 X	GP01-40	2/37
Pyrene	7.5	460 X	GP01-40	2/37
Benzo(a)anthracene	4.6	190 X	GP01-40	2/37
Chrysene	7.7	190 X	GP01-40	2/37
Benzo(b)fluoranthene	15	180 X	GP01-40	3/37
Benzo(k)fluoranthene	4.7	120 X	GP01-40	2/37
Benzo(a)pyrene	5	96 X	GP01-40	2/37
Dibenzo(a,h)anthracene	NA	130 X	GP01-40	1/37
Benzo(ghi)perylene	NA	180 X	GP01-40	1/37
Indeno(1,2,3-cd)pyrene	2.6	30 X	GP01-40	2/37
Pentachlorophenol*	NA	430	GP38-24	1/14
CLP Laboratory Results				
VOC (µg/L)				
Methylene chloride	7 J	11 J	GP18-24	3/4
Acetone	2 J	35 J	GP08-24	4/4
Chloroform	NA	8 J	GP08-24	1/4
CLP Laboratory Results (Cont.)				
VOC (µg/L) (Cont.)				

Key at end of table.

<p align="center">Table 2-13</p> <p align="center">SUMMARY OF CONTAMINANT CONCENTRATIONS</p> <p align="center">GEOPROBE GROUNDWATER SAMPLES</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>				
Contaminant	Minimum Detected Concentration	Maximum Detected Concentration	Location(s) of Maximum Concentration	Frequency of Detection
Benzene	NA	6,600 J	GP08-24	1/4
Toluene	2 J	3,400 J	GP08-24	2/4
Ethylbenzene	NA	800	GP08-24	1/4
Xylene (total)	NA	2,400	GP08-24	1/4
SVOC (µg/L)				
Phenol	NA	10	GP08-24	1/4
2-Methylphenol	NA	1 J	GP08-24	1/4
4-Methylphenol	NA	3 J	GP08-24	1/4
Naphthalene	NA	84	GP08-24	1/4
2-Methylnaphthalene	NA	22	GP08-24	1/4
Di-n-butylphthalate	NA	2.5 J	GP18-24	1/4
Pesticide/PCB (µg/L)				
Heptachlor	NA	0.13 J	GP08-24	1/4
Inorganic (µg/L)				
Aluminum	165	3,250	GP12-24	4/4
Antimony	1.4 J	2.9 J	GP07-20	4/4
Arsenic	NA	24.3	GP08-24	1/4
Barium	96.3	394	GP08-24	4/4
Calcium	110,000	308,000	GP18-24	4/4
Chromium	1.5	6.7	GP12-24	4/4
Cobalt	2.1 J	5.2	GP08-24	4/4
Copper	1.3	5.3	GP12-24	2/4
Iron	983	4,600	GP08-24	4/4
Magnesium	27,200	69,900	GP18-24	4/4
CLP Laboratory Results (Cont.)				
Inorganic (µg/L) (Cont.)				
Manganese	87.8	3,100	GP08-24	4/4
Nickel	8.2	13	GP07-20	4/4

<p style="text-align: center;">Table 2-13</p> <p style="text-align: center;">SUMMARY OF CONTAMINANT CONCENTRATIONS</p> <p style="text-align: center;">GEOPROBE GROUNDWATER SAMPLES</p> <p style="text-align: center;">JENNISON-WRIGHT SITE</p> <p style="text-align: center;">GRANITE CITY, ILLINOIS</p>				
Contaminant	Minimum Detected Concentration	Maximum Detected Concentration	Location(s) of Maximum Concentration	Frequency of Detection
Potassium	3,440	5,420	GP12-24	4/4
Sodium	18,700	53,900	GP07-20	4/4
Thallium	3.8	4.4	GP08-24	3/4
Vanadium	1.1	9.5	GP12-24	3/4
Zinc	6.6 J	25.6 J	GP12-24	4/4

Note: This table reports only organics and inorganics that were detected in the analysis. The total number of samples does not include duplicate samples. Results of PAH screening investigative samples GP03-40, GP16-24, and GP17-24, and CLP investigative sample GP18-24 were averaged with the results of the duplicate sample to obtain a concentration representative of the location.

* This PCP analysis represents the 14 Geoprobe groundwater samples collected in September and December 1997, and analyzed at E & E's ASC using a single-column screening method for PCP (EPA Method 8270).

Key:

- CLP = Contract Laboratory Program.
- J = Value is estimated.
- NA = Not applicable.
- µg/L = Micrograms per liter.
- PAH = Polynuclear aromatic hydrocarbon.
- PCB = Polychlorinated biphenyl.
- PCP = Pentachlorophenol.
- SVOC = Semivolatile organic compound.
- VOC = Volatile organic compound.
- X = Exceeds calibration limits; result is usable.

<p align="center">Table 2-14</p> <p align="center">SUMMARY OF CONTAMINANT CONCENTRATIONS</p> <p align="center">MONITORING WELL GROUNDWATER SAMPLES</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>				
Contaminant	Minimum Detected Concentration	Maximum Detected Concentration	Location(s) of Maximum Concentration	Frequency of Detection
CLP Laboratory Results				
VOC (µg/L)				
Methylene chloride	2 J	24 J	MW-5S	17/21
Acetone	NA	89	MW-8S	1/21
Carbon disulfide	NA	1 J	MW-9M	1/21
1,2-Dichloroethane	3 J	12	MW-6M	2/21
2-Butanone	NA	59	MW-8S	1/21
1,1,1-Trichloroethane	NA	19	MW-10S	1/21
Trichloroethene	NA	9 J	MW-8S	1/21
Benzene	9 J	930	MW-5S	3/21
4-Methyl-2-pentanone	NA	19	MW-8S	1/21
Tetrachloroethene	NA	1 J	MW-9M	1/21
Toluene	2 J	450	MW-5S	4/21
Ethylbenzene	2 J	66 J	MW-5S	4/21
Styrene	9 J	65 J	MW-5S	2/21
Xylene (total)	7 J	240	MW-5S	4/21
SVOC (µg/L)				
Phenol	NA	6,000 J	MW-5S	1/21
2-Methylphenol	NA	21,000	MW-5S	1/21
4-Methylphenol	NA	60,000	MW-5S	1/21
2,4-Dimethylphenol	1 J	15,000	MW-5S	2/21
Naphthalene	12	21,000	MW-5S	3/21
2-Methylnaphthalene	65	540	MW-5S	2/21
2-Chloronaphthalene	NA	2 J	MW-8M	1/21
Acenaphthylene	4 J	44 J	MW-5S	4/21
Acenaphthene	1 J	460	MW-5S	7/21

Key at end of table.

<p align="center">Table 2-14</p> <p align="center">SUMMARY OF CONTAMINANT CONCENTRATIONS</p> <p align="center">MONITORING WELL GROUNDWATER SAMPLES</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>				
Contaminant	Minimum Detected Concentration	Maximum Detected Concentration	Location(s) of Maximum Concentration	Frequency of Detection
CLP Laboratory Results (Cont.)				
SVOC (µg/L) (Cont.)				
Dibenzofuran	37	250	MW-5S	4/21
Fluorene	2 J	210	MW-5S	5/21
Pentachlorophenol	13 J	88,000 J	MW-8S	4/21
Phenanthrene	2 J	240	MW-5D	5/21
Anthracene	1 J	4 J	MW-9S	2/21
Carbazole	2 J	150	MW-5D	4/21
Fluoranthene	5 J	55	MW-5D	3/21
Pyrene	3 J	32	MW-5D	3/21
Benzo(a)anthracene	NA	5 J	MW-5D	1/21
Chrysene	NA	5 J	MW-5D	1/21
Bis(2-ethylhexyl)phthalate	2 J	10	MW-1D	6/21
Benzo(b)fluoranthene	NA	2 J	MW-5D	1/21
Benzo(k)fluoranthene	NA	2 J	MW-5D	1/21
Benzo(a)pyrene	NA	2 J	MW-5D	1/21
Pesticide/PCB (µg/L)				
alpha-BHC	NA	0.26 J	MW-8S	1/21
gamma-BHC (Lindane)	NA	0.089 J	MW-5S	1/21
Heptachlor	NA	0.13 J	MW-5S	1/21
Endosulfan I	NA	0.12 J	MW-5D	1/21
alpha-Chlordane	NA	0.17 J	MW-5S	1/21
Inorganic (µg/L)				
Aluminum	19.9 J	138 J	MW-6D	21/21
Arsenic	2 J	64 J	MW-8S	7/21
Barium	76.9	833	MW-6D	21/21

Key at end of table,

<p style="text-align: center;">Table 2-14</p> <p style="text-align: center;">SUMMARY OF CONTAMINANT CONCENTRATIONS</p> <p style="text-align: center;">MONITORING WELL GROUNDWATER SAMPLES</p> <p style="text-align: center;">JENNISON-WRIGHT SITE</p> <p style="text-align: center;">GRANITE CITY, ILLINOIS</p>				
Contaminant	Minimum Detected Concentration	Maximum Detected Concentration	Location(s) of Maximum Concentration	Frequency of Detection
CLP Laboratory Results (Cont.)				
Inorganic (µg/L) (Cont.)				
Cadmium	0.3 J	1.0	MW-8S	16/21
Calcium	87,400	194,000	MW-9S	21/21
Chromium	1.1 J	8.3 J	MW-5D	12/21
Cobalt	1.5	9.9	MW-9D	8/21
Copper	3.4 J	48.1 J	MW-9D	21/21
Iron	30.9 J	24,500	MW-8S	21/21
Lead	1.3 J	55.9 J	MW-8S	21/21
Magnesium	18,900	56,600	MW-9S	21/21
Manganese	0.7 J	5,810	MW-5S	21/21
Nickel	5.1	49.1	MW-5D	13/21
Potassium	2,840 J	9,580 J	MW-8M	21/21
Selenium	2.4	20.6	MW-1S	7/21
Silver	NA	1.1	MW-5S	1/21
Sodium	10,300	101,000	MW-5S	21/21
Vanadium	1.6	2.5	MW-5S	2/21
Zinc	19.2 J	81.5 J	MW-3S	6/21
Cyanide	NA	7.1 J	MW-6D	1/21

Note: This table reports only organics and inorganics that were detected in the analysis. The total number of samples does not include duplicate samples. Results of samples MW-3S, MW-8M, and MW-9M were averaged with the results of the duplicate sample to obtain a concentration representative of the location.

Key:

CLP = Contract Laboratory Program.
J = Value is estimated.
µg/L = Micrograms per liter.
NA = Not applicable.
PCB = Polychlorinated biphenyl.
SVOC = Semivolatile organic compound.
VOC = Volatile organic compound.

<p align="center">Table 2-15</p> <p align="center">SUMMARY OF CONTAMINANT CONCENTRATIONS</p> <p align="center">SEDIMENT SAMPLES</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>				
Contaminant	Minimum Detected Concentration	Maximum Detected Concentration	Location(s) of Maximum Concentration	Frequency of Detection
CLP Laboratory Results				
VOC (µg/kg)				
Methylene chloride	3 J	800 J	SD04	3/4
Acetone	NA	45 J	SD01	1/4
Chloroform	NA	540 J	SD03	1/4
Benzene	870 J	5,800	SD03	2/4
Toluene	2 J	33,000	SD03	3/4
Ethylbenzene	725 J	72,000	SD03	2/4
Styrene	350 J	17,000	SD03	2/4
Xylene (total)	2,400 J	110,000	SD03	2/4
SVOC (µg/kg)				
1,4-Dichlorobenzene	NA	13,000 J	SD03	1/4
4-Methylphenol	NA	13,000 J	SD03	1/4
Naphthalene	4,050,000 J	13,000,000	SD03	2/4
2-Methylnaphthalene	31,000 J	3,400,000	SD03	3/4
Acenaphthylene	12,000 J	205,000	SD04	4/4
Acenaphthene	16,000 J	5,400,000	SD04	4/4
Dibenzofuran	19,000 J	5,300,000	SD04	4/4
Fluorene	49,000 J	9,450,000	SD04	4/4
Phenanthrene	940,000	30,000,000	SD04	4/4
Anthracene	200,000	16,300,000	SD04	4/4
Carbazole	58,000	6,650,000	SD04	4/4
Fluoranthene	1,700,000	25,000,000	SD02	4/4
Pyrene	1,100,000	16,000,000	SD02	4/4

Key at end of table.

<p align="center">Table 2-15</p> <p align="center">SUMMARY OF CONTAMINANT CONCENTRATIONS</p> <p align="center">SEDIMENT SAMPLES</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>				
Contaminant	Minimum Detected Concentration	Maximum Detected Concentration	Location(s) of Maximum Concentration	Frequency of Detection
CLP Laboratory Results (Cont.)				
SVOC (µg/kg) (Cont.)				
Benzo(a)anthracene	200,000	3,800,000	SD02	4/4
Chrysene	280,000	4,000,000	SD02	4/4
bis(2-Ethylhexyl)phthalate	4,400 J	34,000 J	SD02	4/4
Benzo(b)fluoranthene	86,000	1,400,000	SD02	4/4
Benzo(k)fluoranthene	100,000	1,800,000 J	SD02	4/4
Benzo(a)pyrene	50,000	1,200,000	SD02	4/4
Indeno(1,2,3-cd)pyrene	26,000 J	380,000	SD02	4/4
Dibenzo(a,h)anthracene	11,000 J	190,000	SD02	4/4
Benzo(g,h,i)perylene	26,000 J	310,000	SD02	4/4
Pesticide/PCB (µg/kg)				
alpha-BHC	14 J	19 J	SD04	2/4
beta-BHC	8.1 J	76 J	SD04	2/4
Heptachlor	8.2 J	18 J	SD04	2/4
Aldrin	4.6 J	26 J	SD04	3/4
Heptachlor epoxide	6.2 J	16 J	SD04	3/4
Endosulfan I	37 J	48 J	SD04	2/4
Dieldrin	18 J	120 J	SD02	3/4
Endrin	15 J	280 J	SD02	4/4
Endosulfan II	9.8 J	230 J	SD04	4/4
4,4'-DDD	22 J	200 J	SD04	3/4
Endosulfan sulfate	46 J	80 J	SD04	2/4
4,4'-DDT	14 J	200 J	SD02	3/4

Key at end of table.

<p align="center">Table 2-15</p> <p align="center">SUMMARY OF CONTAMINANT CONCENTRATIONS</p> <p align="center">SEDIMENT SAMPLES</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>				
Contaminant	Minimum Detected Concentration	Maximum Detected Concentration	Location(s) of Maximum Concentration	Frequency of Detection
CLP Laboratory Results (Cont.)				
Pesticide/PCB (µg/kg) (Cont.)				
Methoxychlor	180 J	205 J	SD04	2/4
Endrin ketone	82 J	110 J	SD02	3/4
Endrin aldehyde	75 J	500 J	SD04	4/4
alpha-Chlordane	33 J	210 J	SD04	2/4
Inorganic (mg/kg)				
Aluminum	6,050	11,300	SD01	3/4
Antimony	1.8 BN	12.6	SD04	4/4
Arsenic	4.1 B	14.8	SD04	4/4
Barium	110 *	187 *	SD03	4/4
Beryllium	0.81 B	1.6 B	SD03	2/4
Cadmium	0.63 B	4.7	SD04	4/4
Calcium	21,700	63,200	SD01	4/4
Chromium	39.7	95.9	SD04	4/4
Cobalt	3.3 B	12	SD04	4/4
Copper	52.2	216	SD04	4/4
Iron	13,800	63,400	SD04	4/4
Lead	65.8	196	SD04	4/4
Magnesium	4,000	17,800	SD04	4/4
Manganese	753	1,150	SD03	4/4
Mercury	0.11 B	1.7	SD04	4/4
Nickel	10.8 B	48.5	SD04	4/4
Potassium	917 B	1960 J	SD01	4/4

Key at end of table.

<p align="center">Table 2-15</p> <p align="center">SUMMARY OF CONTAMINANT CONCENTRATIONS</p> <p align="center">SEDIMENT SAMPLES</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>				
Contaminant	Minimum Detected Concentration	Maximum Detected Concentration	Location(s) of Maximum Concentration	Frequency of Detection
CLP Laboratory Results (Cont.)				
Inorganic (mg/kg) (Cont.)				
Selenium	1.8	2.1	SD02	2/4
Sodium	527 B	5,870	SD03	4/4
Thallium	1.8 B	5.5	SD02	2/4
Vanadium	52.8	80.4	SD01	4/4
Zinc	216	1,540	SD01	4/4
Cyanide	0.56 B	4.2	SD04	4/4

Note: This table reports only organics and inorganics that were detected in the analysis. The total number of samples does not include duplicate samples. Results of investigative sample SD04 were averaged with the results of the duplicate sample to obtain a concentration representative of the location.

Key:

- CLP = Contract Laboratory Program.
- B = Value is estimated (inorganics).
- J = Value is estimated.
- µg/kg = Micrograms per kilogram.
- mg/kg = Milligrams per kilogram.
- N = Because the laboratory matrix spike recovery was outside of quality control (QC) protocols, the value is estimated and may be biased high or low.
- NA = Not applicable.
- PCB = Polychlorinated biphenyl.
- SVOC = Semivolatile organic compound.
- VOC = Volatile organic compound.
- * = Because the laboratory duplicate was outside of QC protocols, the value is estimated and may be biased high or low.

<p style="text-align: center;">Table 2-16</p> <p style="text-align: center;">ASBESTOS-CONTAINING MATERIAL SUMMARY</p> <p style="text-align: center;">JENNISON-WRIGHT SITE</p> <p style="text-align: center;">GRANITE CITY, ILLINOIS</p>			
Sample Identification	Asbestos Detected and Percentage	Fibrous Material and Percentage	Non-Fibrous Material and Percentage
OB01	Chrysotile-02	Fibrous Glass-01	Vinyl-19 Quartz-04 Carbonates-74
OB02	None	Cellulose-99	Paint-01
BB03	Chrysotile-18	Cellulose-80	Carbonates-02
GB04	None	Mineral Wool-99	Carbonates-01
BB05	Chrysotile-38	Cellulose-52	Carbonates-10
BB06	None	Fibrous Glass-22 Cellulose-09	Foil-58 Carbonates-11
TB07	Chrysotile-19	Cellulose-01	Quartz-15 Carbonates-65
TB08	None	Cellulose-99	Carbonates-01
WB09	None	Cellulose-04	Gypsum-15 Quartz-03 Carbonates-78
WB10	Chrysotile-16	Cellulose-09	Carbonates-75
WB11	Amosite-08	Fibrous Glass-90	Carbonates-02
PB12	None	Cellulose-12	Carbonates-06 Tar-82
WB13	None	Cellulose-15	Carbonates-08 Tar-77
BB14	None	Cellulose-14	Carbonates-10 Tar-76

Key:

BB = Boiler building.
GB = Green building.
OB = Office building.
PB = Collapsed pole barn.
TB = Transite building.
WB = White building.

<p align="center">Table 2-17</p> <p align="center">BIOFEASIBILITY STUDY—GENERAL CHEMISTRY RESULTS</p> <p align="center">(mg/L except pH)</p>				
Parameter	Sample			
	SB32 (6-7)	SB33 (12-13)	MW5S	MW10S
Ammonia	18.5	162	1.46	0.22
Nitrate	<1.0	35.8	10.8	3.89
Nitrite	<1.0	<1.0	<0.10	<0.10
pH	5.92	8.85	7.01	7.17
o-Phosphorus	2.85	6.75	<0.01	0.027
TOC	420	33,100	588	9.3
Sulfate	<100	<500	53	117
Iron	16,000	19,500	21.4	20.7

Key:

TOC = Total Organic Carbon.
mg/L = Milligrams per liter.
< = Less than.



LEGEND:

- FENCE
- SS36 — SURFACE SOIL GRID SAMPLE LOCATION
- SS96 — SURFACE SOIL BIASED SAMPLE LOCATION

NOTE: SAMPLES SS09, SS31, AND SS54 WERE NOT COLLECTED AS THEIR CORRESPONDING GRID NODES WERE LOCATED OFF SITE OR ON DEBRIS PILES. SAMPLE SS93 WAS COLLECTED AS A SEDIMENT SAMPLE (SD04) FROM THE OVAL SUMP.

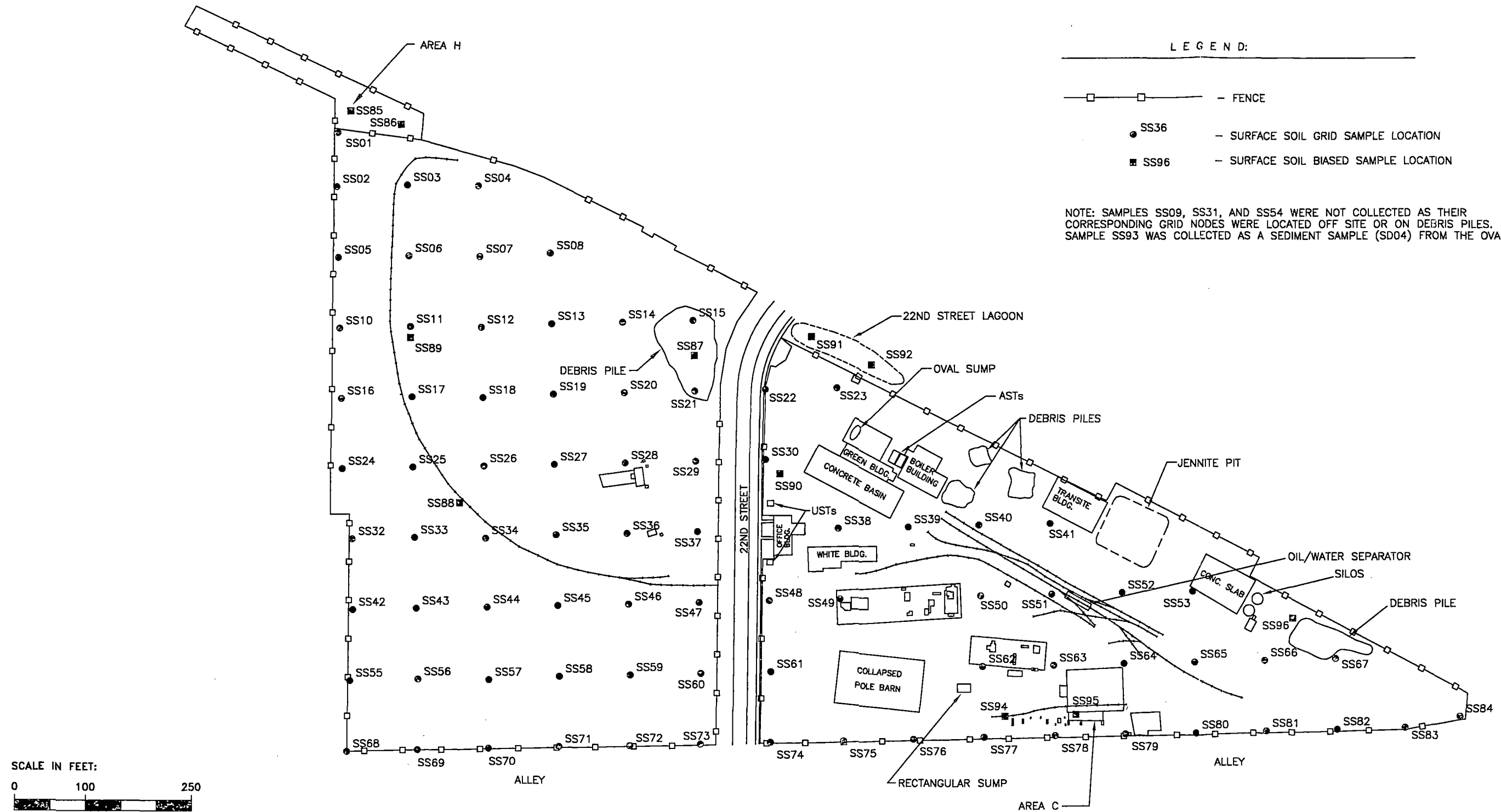


Figure 2-1 SURFACE SOIL SAMPLE LOCATIONS
JENNISON-WRIGHT SITE
GRANITE CITY, ILLINOIS

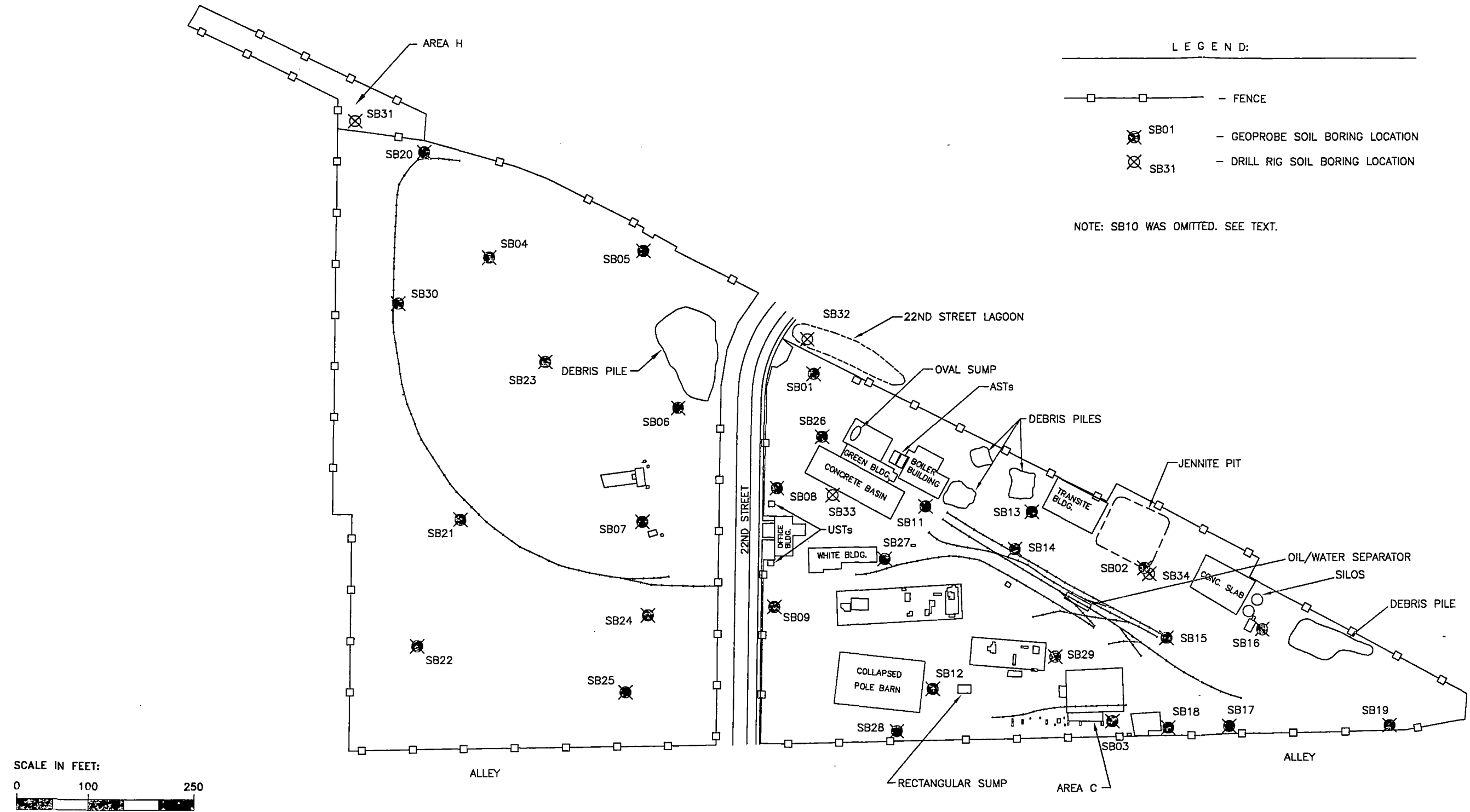


Figure 2-2 SOIL BORING LOCATIONS
JENNISON-WRIGHT SITE
GRANITE CITY, ILLINOIS

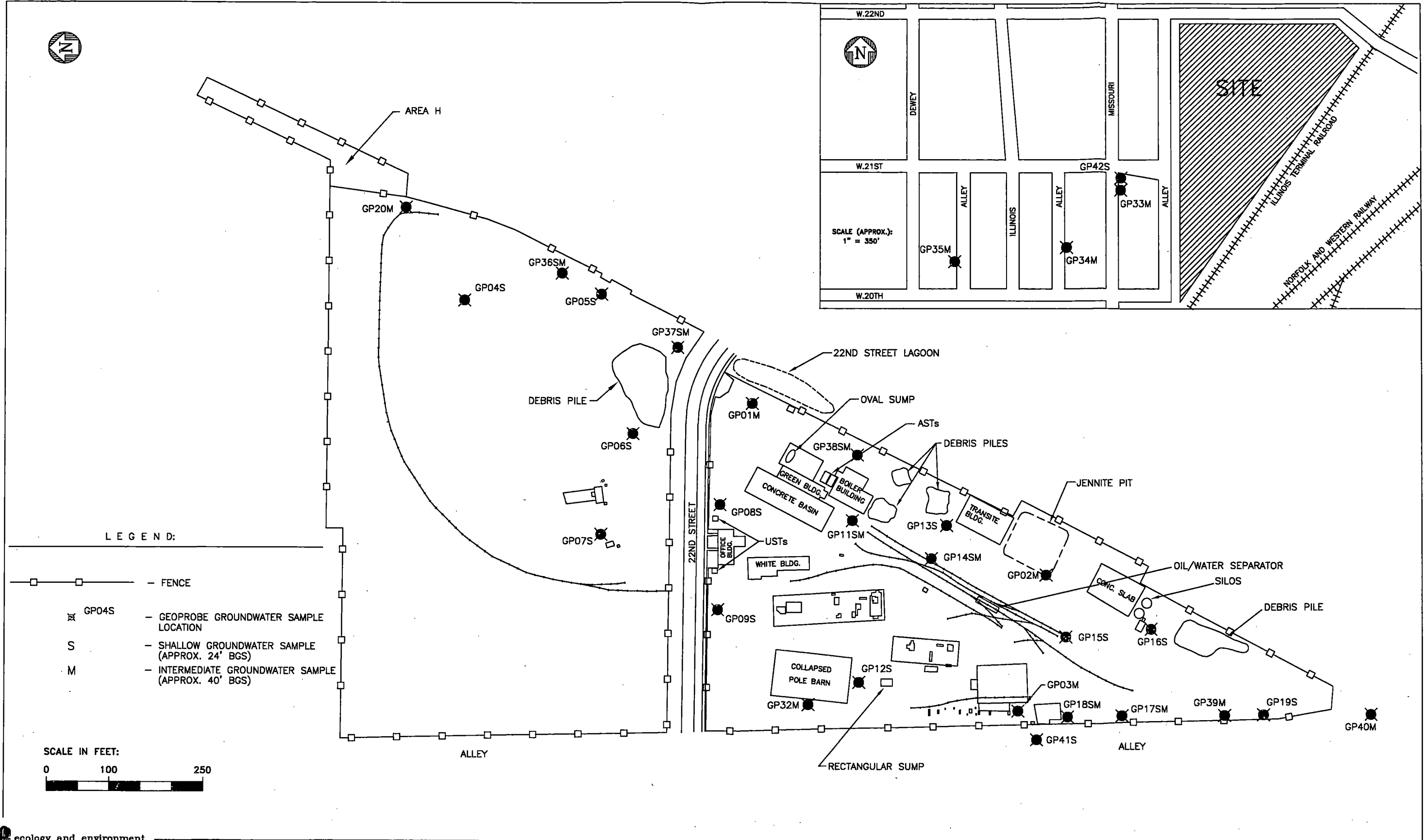


Figure 2-3 GEOPROBE GROUNDWATER SAMPLE LOCATIONS
JENNISON-WRIGHT SITE
GRANITE CITY, ILLINOIS



LEGEND:

- FENCE
- MW-11M — NEW MONITORING WELLS (E & E, 1997)
- MW-5S — EXISTING MONITORING WELLS (WCC, 1988)
- OLD8S — "OLD" MONITORING WELLS (E & E, 1984)
- S — SHALLOW MONITORING WELL
- M — INTERMEDIATE MONITORING WELL
- D — DEEP MONITORING WELL

SCALE IN FEET:

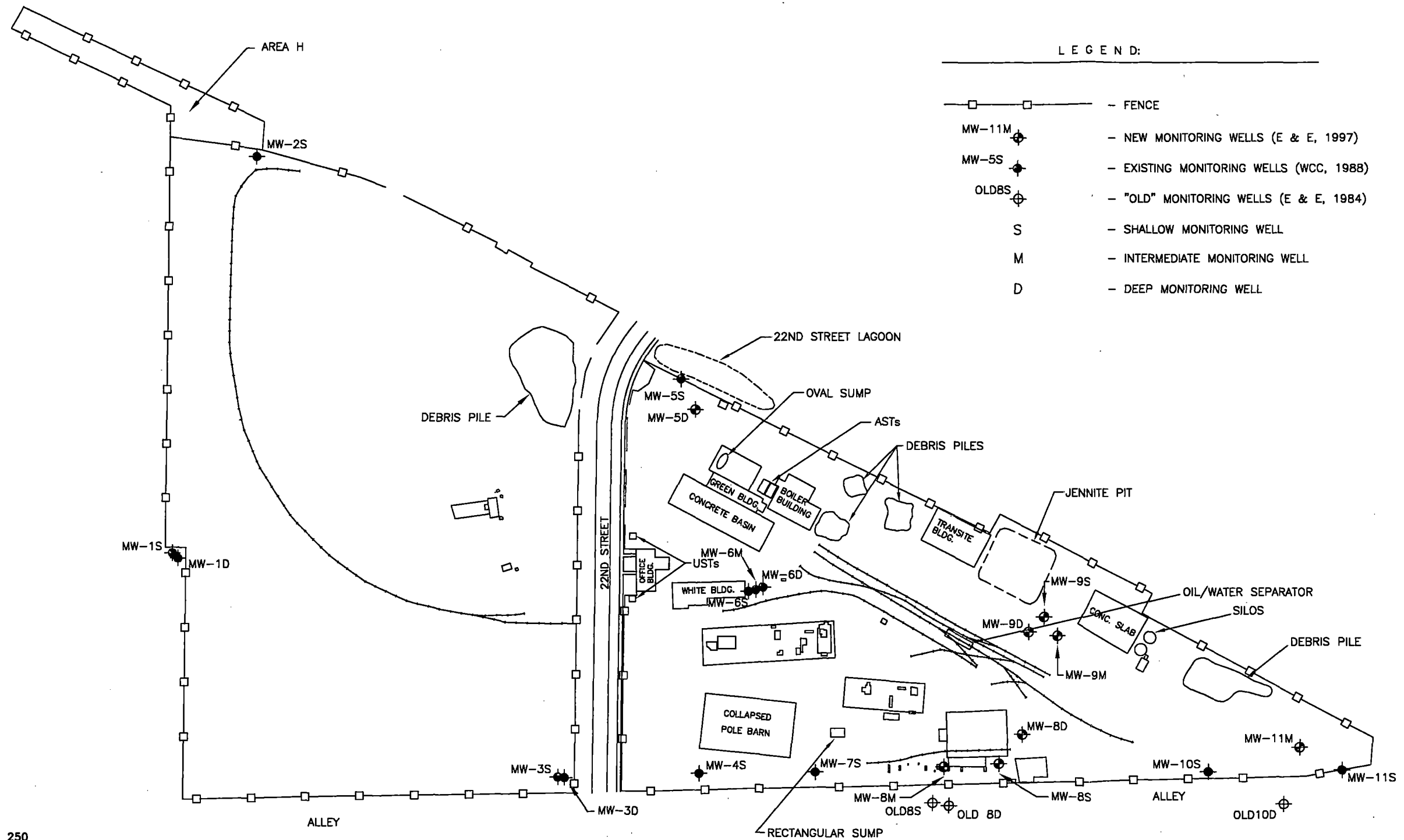
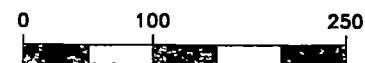


Figure 2-4. MONITORING WELL LOCATIONS
JENNISON-WRIGHT SITE
GRANITE CITY, ILLINOIS



LEGEND:

- FENCE
- SD01 ▲ — SEDIMENT SAMPLE LOCATION

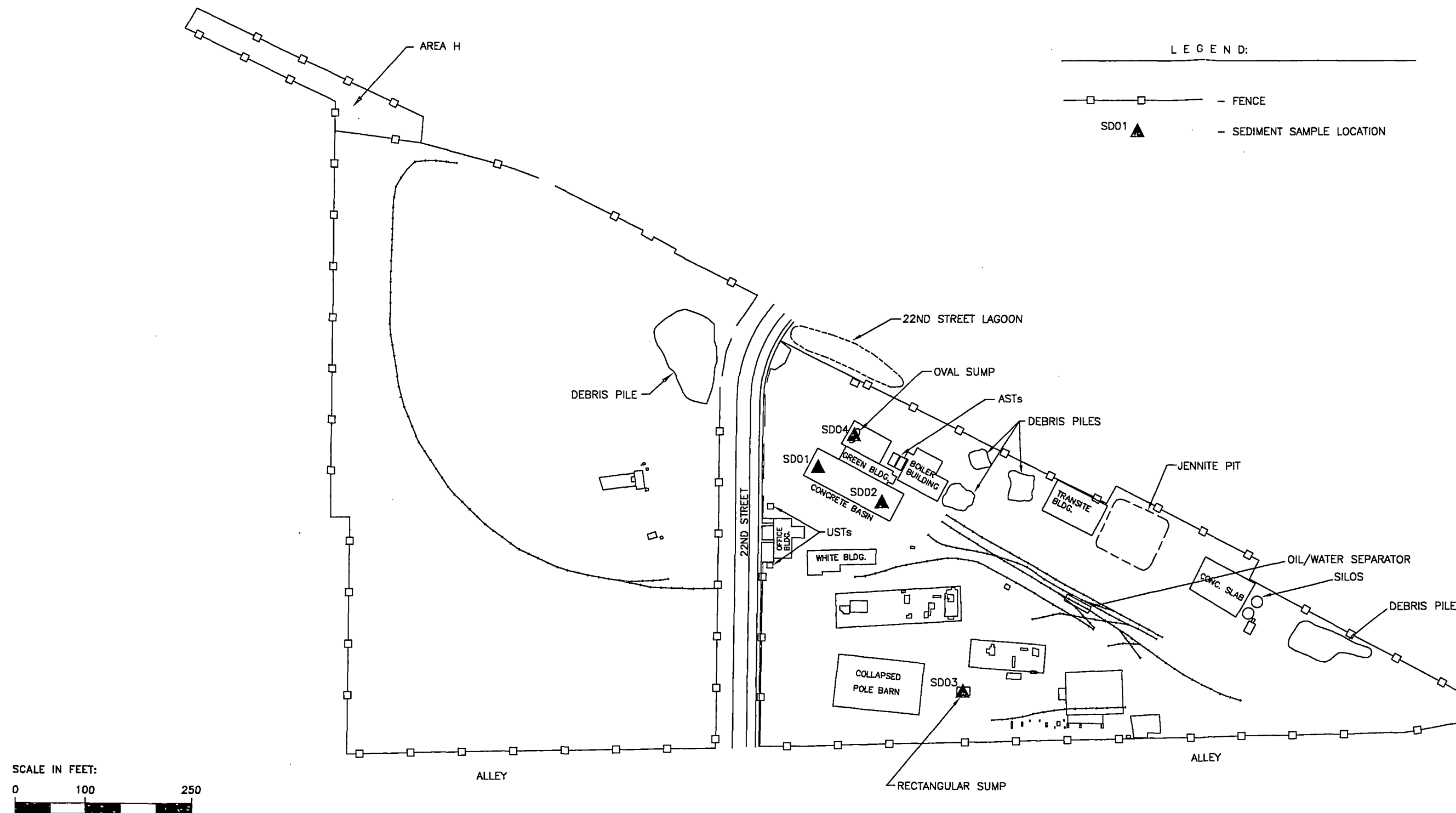


Figure 2-5 SEDIMENT SAMPLE LOCATIONS
JENNISON-WRIGHT SITE
GRANITE CITY, ILLINOIS

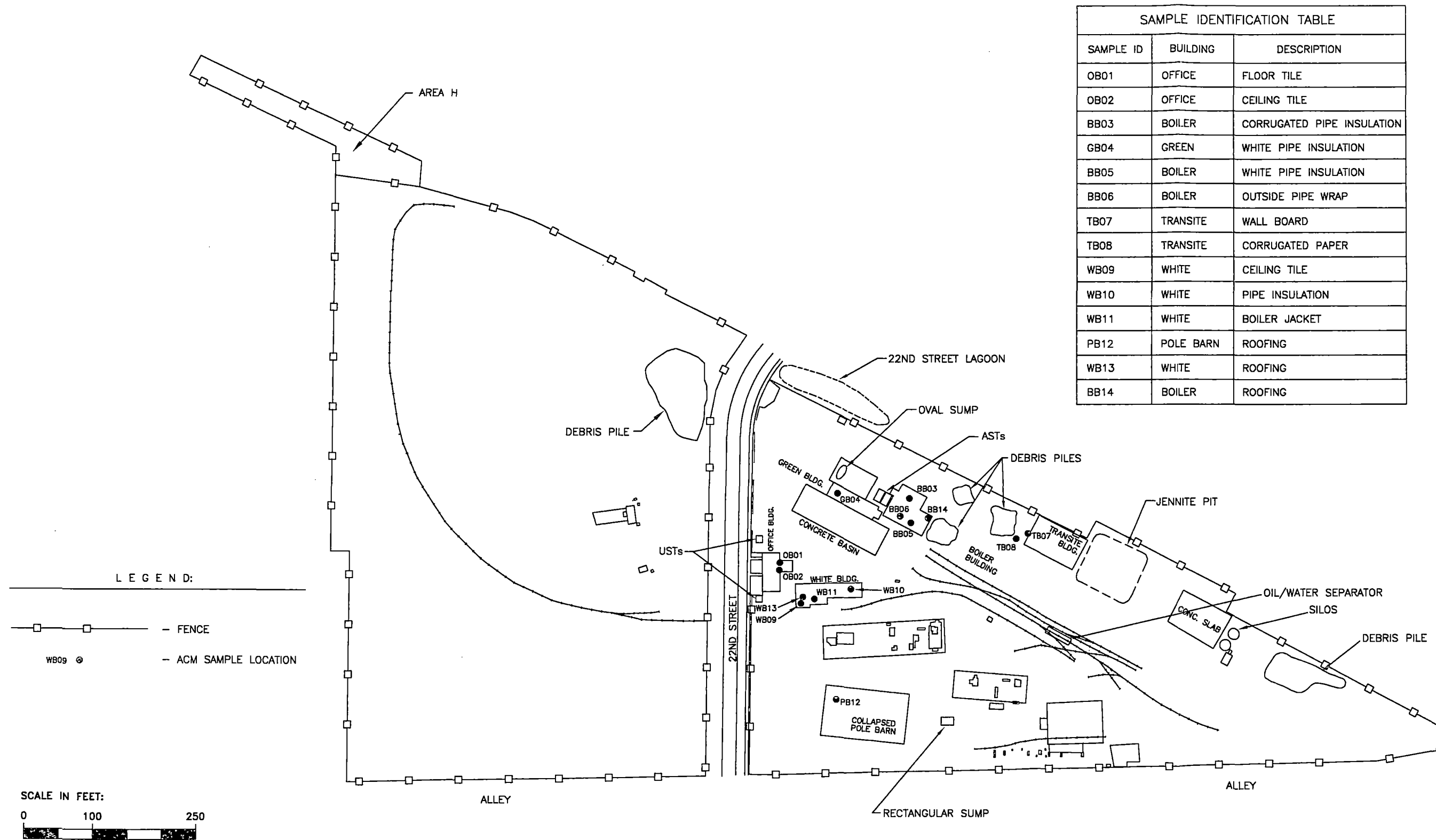


Figure 2-6 ACM SAMPLE LOCATIONS
JENNISON-WRIGHT SITE
GRANITE CITY, ILLINOIS



LEGEND:

- FENCE
- MW-2S 404.53 - SHALLOW MONITORING WELL/GROUNDWATER ELEVATION
- 403.8 - GROUNDWATER CONTOUR ELEVATION (FEET ABOVE MSL)
- GROUNDWATER FLOW DIRECTION

SCALE IN FEET:

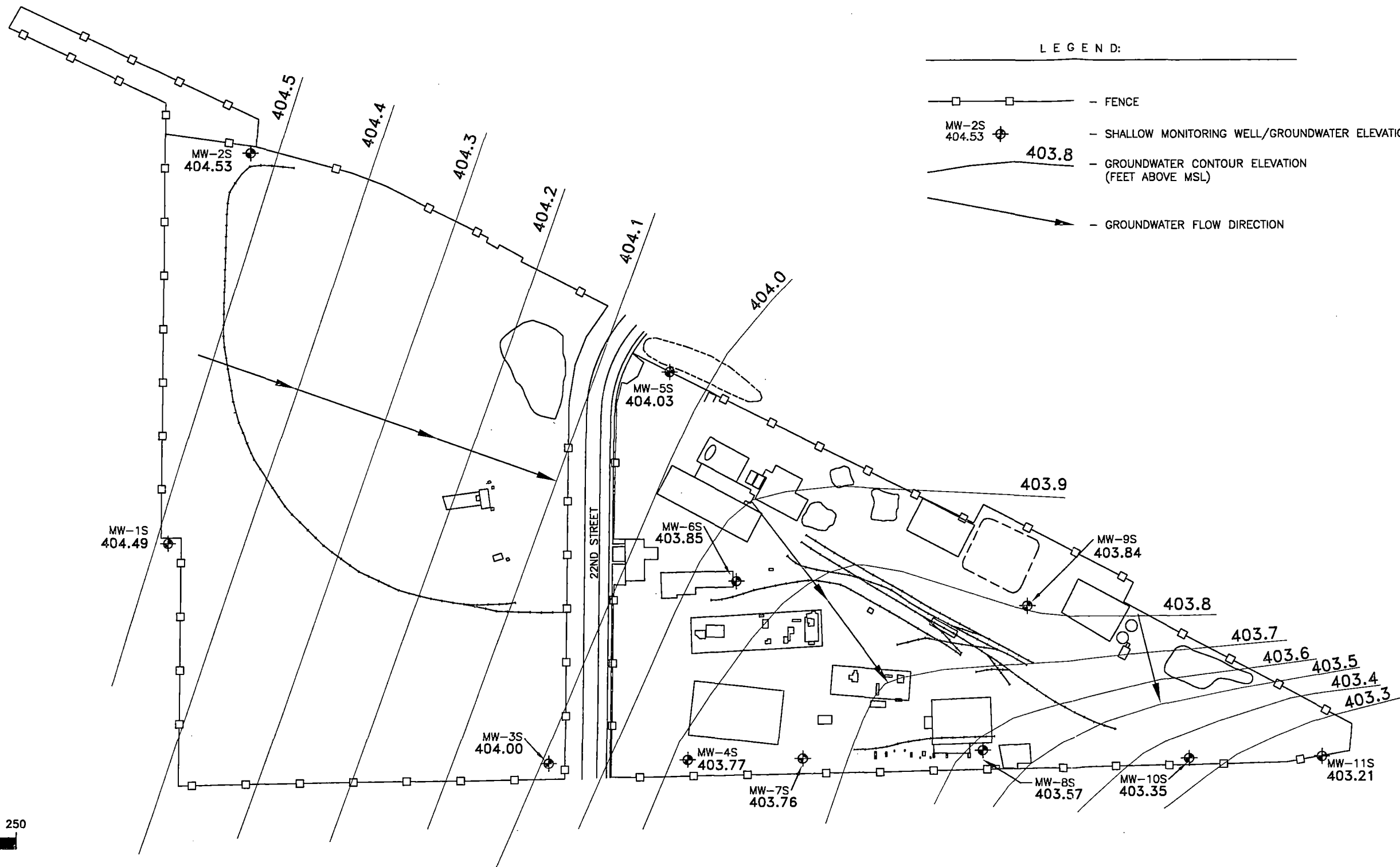
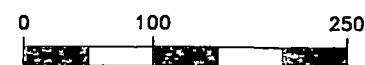


Figure 2-7 SHALLOW GROUNDWATER ELEVATION CONTOUR MAP (SEPTEMBER 5, 1997)
JENNISON-WRIGHT SITE
GRANITE CITY, ILLINOIS



LEGEND:

- FENCE
- MW-11M - INTERMEDIATE/DEEP MONITORING WELL/
GROUNDWATER ELEVATION
- 403.5 - GROUNDWATER CONTOUR ELEVATION
(FEET ABOVE MSL)
- GROUNDWATER FLOW DIRECTION

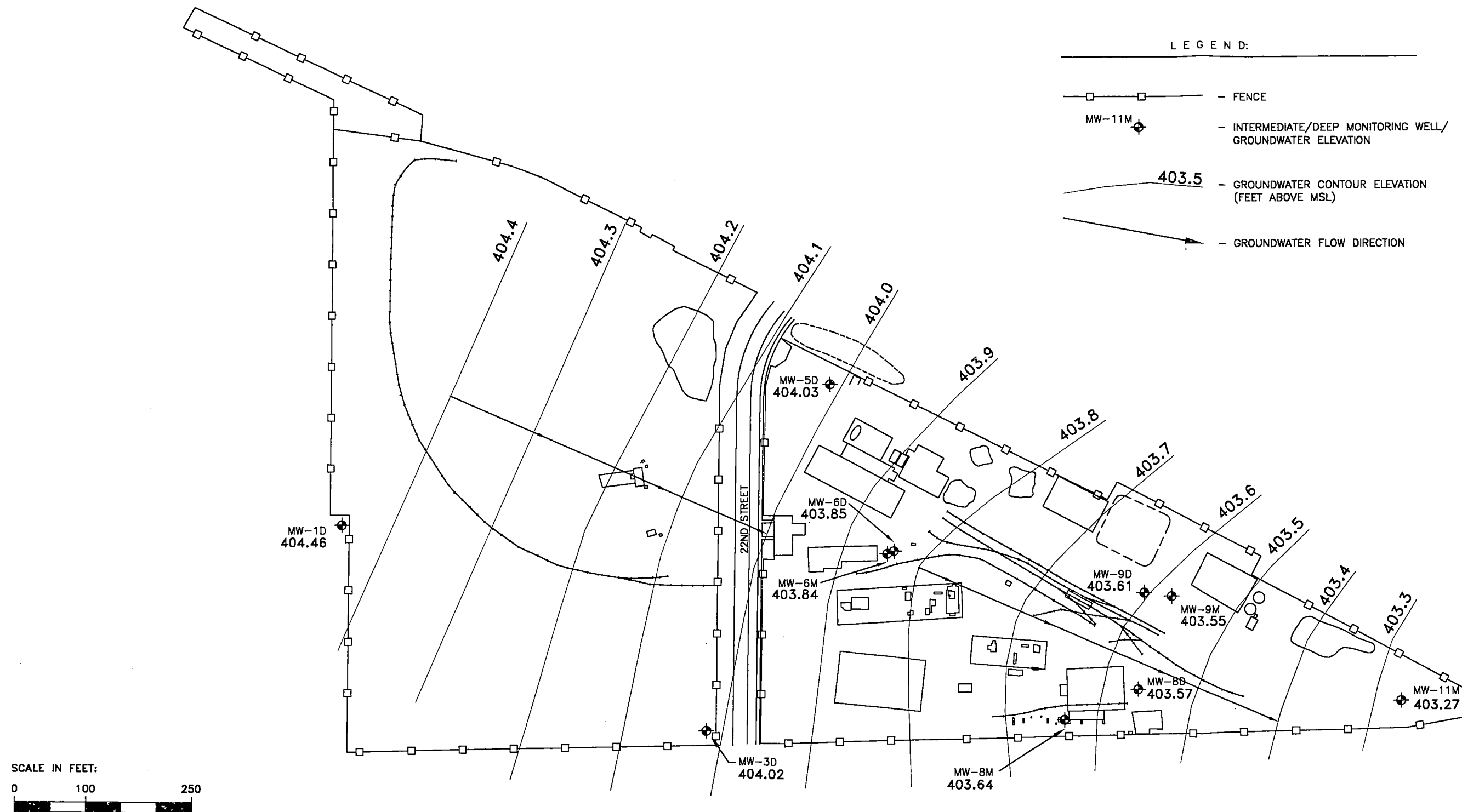


Figure 2-8 INTERMEDIATE/DEEP GROUNDWATER
ELEVATION CONTOURS
(SEPTEMBER 5, 1997)
JENNISON-WRIGHT SITE
GRANITE CITY, ILLINOIS

3

Streamlined Risk Evaluation

SRE

streamlined risk
evaluation

HHRE

human health risk
evaluation

RAGS

*Risk Assessment
Guidance for Superfund*
(EPA 1989)

COPCs

chemicals of potential
concern

EPA guidance on conducting non-time-critical removal actions (EPA 1993) requires that a streamlined risk evaluation (SRE) be included as a component of the EE/CA in order to assist in determining whether a removal action is required, and to identify the potential current and future exposures that should be prevented. The SRE is intermediate in scope between the limited risk evaluation performed for a removal action and the conventional baseline risk assessment conducted for remedial actions. The SRE is intended to evaluate the existing and potential risks posed by the specific problem that the removal action is intended to address, and can be both qualitative and quantitative in nature (EPA 1993).

The specific purpose of this SRE is to evaluate potential risks to humans and the environment as a result of exposure to contaminants present in soil and groundwater at the JW site. The streamlined human health risk evaluation is presented in Section 3.1. The streamlined ecological risk evaluation is presented in Section 3.2. Wastes present in drains, sumps, and tanks on site and ACM were considered to be obvious threats to human health and the environment and, therefore, were not included in this evaluation.

3.1 Streamlined Human Health Risk Evaluation

The human health risk evaluation (HHRE) has been prepared and organized generally in accordance with EPA guidance, including, but not limited to, *Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual* (RAGS) (EPA 1989). The HHRE reviews the available data and identifies chemicals of potential concern (COPCs) at the site, assesses potential exposure of receptors to the COPCs and the toxicity of the COPCs, and then integrates the exposure and toxicity assessments into an overall risk evaluation. The primary risks associated with the site are identified, along with the pathways and chemicals giving rise to those risks. Discussions of the site background and sampling and analyses conducted during the EE/CA site characterization investigation are described in Sections 1 and 2 and are only summarized in subsequent sections of the SRE.

3. Streamlined Risk Evaluation

3.1.1 Identification of Chemicals of Potential Concern

3.1.1.1 Data Collection

The objectives of the EE/CA field investigation were to characterize the nature and extent of contamination associated with former site activities, as well as to assess the site topography, geology, and hydrogeology, in order to identify and evaluate potential migration and exposure pathways of the COPCs.

The investigative activities carried out to achieve these objectives are described in detail in Section 2 of this report. Environmental samples collected included on-site surface and subsurface soils, and groundwater from existing and newly installed monitoring wells on site. All surface soil grid samples were analyzed for PAHs by E & E's ASC, and field-screened for PCP. In addition, 16 of the grid samples were analyzed under EPA's CLP Program for TCL VOCs, SVOCs, pesticides/PCBs, and TAL inorganics.

Eleven biased surface soil samples were collected from known disposal areas and analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL inorganics, and dioxins/furans.

A total of 61 groundwater samples (37 Geoprobe screening samples and 24 monitoring well samples) were collected from 30 Geoprobe locations and 24 monitoring well locations. In addition, four sediment samples were collected from a concrete basin and sumps on site, and 14 samples of building materials were analyzed for ACM. The results of sediment and ACM sampling were not used in the HHRE, however, because the wastes in the basin and sumps the ACM were considered to be obvious threats to human health.

QA/QC
quality assurance/quality
control

Sampling of environmental media was carried out using standard EPA methodologies and quality assurance/quality control (QA/QC) procedures. The specific methods used are described in Section 2.

3.1.1.2 Data Qualifiers

Several types of data qualifiers are associated with a number of the analytical values reported and validated in the data evaluation process. In accordance with RAGS (EPA 1989), if an analyte was found in a blank (B flag), values for the corresponding samples were included in the risk assessment only if the sample value was more than 10 times the blank value for common laboratory contaminants, or more than five times the blank value for other compounds.

Estimated values (J flags) were used because they are the best available estimates of the true concentrations present. The use of these values marginally decreases the accuracy and confidence in

3. Streamlined Risk Evaluation

quantitative estimates of exposures and risks obtained by using them, which will be noted in discussions of uncertainties.

Nevertheless, the estimated values provided the best estimates obtainable.

SQL
sample quantitation limit

QLs
quantitation limits

PRGs
Preliminary Remediation
Goals

U-flagged values, indicating that the chemical was not detected at the specified sample quantitation limit (SQL), were evaluated on a case-by-case basis. If the chemical was not detected in any samples in the medium (i.e., all of the samples are U-flagged), then it was not considered to be present in that medium and an exposure point concentration was not calculated for the chemical in that particular medium. If a chemical was detected in at least one sample in a medium, then one-half of the SQL was used in place of the U-flagged values in the calculation of exposure point concentrations, unless one-half of the SQL exceeded the maximum concentration of the chemical actually detected in the sample set. In that case, the U-flagged value was excluded from the quantitative evaluation.

Data flagged with an "X" indicate that the calibration limit of the instrument was exceeded. If the sample could not be diluted and reanalyzed, the X-flagged value was used in the risk assessment.

3.1.1.3 Data Validation

Analyses conducted by E & E's ASC were performed using methods and QA/QC procedures set forth in Methods for the Chemical Analysis of Water and Wastes (EPA 1983) and Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Third Edition, Update 2B (EPA 1995a). The 16 surface soil grid samples analyzed by CLP were evaluated using methods and QA/QC procedures specified by CLP. Data validation was performed in accordance with EPA's functional guidelines for evaluating organic and inorganic analyses. Only data approved for use by these procedures were used in the risk assessment.

3.1.1.4 Quantitation Limits

Analytical quantitation limits (QLs) for the samples were mostly the quantitation limits specified by the respective analytical method, or the contract-required quantitation limits specified in the CLP organic and inorganic statements of work. SQLs for chemicals that were not detected in a medium were evaluated by comparison to Preliminary Remediation Goals (PRGs) for soil and groundwater developed by EPA Region 9 (Smucker 1996). SQLs for soil samples were compared to risk-based concentrations for industrial exposure scenarios (ingestion and inhalation). SQLs for groundwater were compared to PRGs for tap water ingestion. In general, sample SQLs for soil and groundwater fell below or within the range of 10^{-6} and 10^{-4} (the range generally considered acceptable by EPA). In some cases SQLs were elevated due to

3. Streamlined Risk Evaluation

matrix interference and subsequent dilutions. Two chemicals, 1,1,2,2-tetrachloroethane and 1,1-dichloroethene, if present in groundwater at their minimum detection limits, would have associated cancer risks exceeding 10^{-4} for residential tap water ingestion.

The QLs for the samples were generally the lowest obtainable, and, with the exception of the two chemicals listed above, were acceptable for use in the SRE. Uncertainties associated with the SQLs are discussed in Section 3.1.5.

3.1.1.5 Background Samples

Concentrations of inorganic compounds were compared to estimated background concentrations for the site area. Four background samples were collected by E & E from two parks within 1 mile of the site (Barry Loman Park and Triangle Park). In addition, 18 surface soil samples collected by IEPA from residences within 1 mile west of the site and from Barry Loman Park were included in the background data set (see Appendix I, Table I-3 for background soil data). The samples taken by IEPA were collected in support of a separate investigation; however, with the exception of lead results in the residential samples, the data collected by IEPA are considered to be representative of local background conditions in the area of the site. The range of lead concentrations detected in the IEPA soil samples and the presence of a potential man-made source of lead in the area suggest that the detected lead concentrations are not representative of naturally occurring background conditions. Consequently, a background concentration was not estimated for lead.

UCL
upper confidence limit

Background concentrations were determined by calculating the 95% upper confidence limit on the mean (UCL) for each analyte. The UCL was calculated assuming that the data were normally distributed. The equation used to calculate the UCL based on a normal distribution is:

Where:

- x = The mean of the sample data;
- t = Student-t statistic (from Gilbert 1987);
- s = Standard deviation of the sample data; and
- n = Number of samples.

The calculated UCLs were then compared to the maximum detected values for each of the inorganic analytes. Analytes that were detected at concentrations below the respective UCL, and that

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were not believed to be associated with any of the former operations at the site were not retained in the risk evaluation. The background sample data and a comparison of the detected analytes with their calculated background levels are presented in Appendix I.

Arsenic detected in one sample from the site slightly exceeded the calculated background level of 11.57 mg/kg; however, the concentration was within the range of background concentrations, and the calculated UCL of the samples collected on site (7.7 mg/kg) was below the estimated background concentration. Based on the site history, arsenic was not used in any of the operations on site. Therefore, arsenic levels detected at the site are believed to represent naturally occurring background levels.

IPCB
Illinois Pollution Control
Board

TACO
*Tiered Approach to
Corrective Action
Objectives*

3.1.1.6 Toxicity Screening

The final step in the COPC selection process was to compare the concentrations of chemicals detected in soil and groundwater to PRGs in order to eliminate those chemicals from the quantitative risk evaluation that are unlikely to contribute significantly to overall risks. The analytical data were compared to Tier 1 lookup values for residential inhalation of air, and for worker soil ingestion, inhalation of air, and Class I groundwater ingestion from the Illinois Pollution Control Board's (IPCB's) *Tiered Approach to Corrective Action Objectives* (TACO) (IPCB 1997). The data were not compared to residential values for soil exposure because the site is assumed to remain industrial (see Section 3.1.2.1). The Tier 1 values correspond to a cancer risk of 10^{-6} or a noncancer hazard quotient of 1. In general, chemicals classified as Group A or B carcinogens were not excluded based on toxicity screening. Certain inorganic analytes considered to be essential nutrients and/or toxic only at high concentrations were also excluded as COPCs.

3.1.1.7 Summary of Analytical Results and Chemicals of Potential Concern

A summary of the data evaluation performed for the HHRE, including frequency of detection and comparison to risk-based screening concentrations is presented in Appendix I. Chemicals selected as COPCs for soil and groundwater are presented in Table 3-1.

Several organic compounds were identified as COPCs in groundwater, but not in soil either because they were not detected in soil at the site, or because the results of toxicity screening indicated that the chemical concentrations detected in soil would not contribute significantly to the overall estimated risk at the site. Arsenic was retained as a COPC in groundwater, but not in soil, based on the comparison to background levels (which indicate that the arsenic concentrations in soil at the site are similar to

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background levels) and on site historical information which does not indicate that arsenic was ever used at the site. Due to the lack of background data for lead, and because lead levels in two of the surface soil samples exceeded the screening level, lead was retained as a COPC in surface soil.

3.1.2 Exposure Assessment

This section evaluates the potential for human contact with the COPCs selected for the site. The routes, duration, frequency, and magnitude of these potential exposures are estimated in this section. Exposure scenarios evaluated for a site generally depend on the populations potentially exposed and the types of land use at the site.

The exposure assessment includes the following steps:

- Characterization of the exposure setting and potentially complete exposure pathways; and
- Quantification of exposure.

The following subsections present the exposure assessment according to the above steps.

3.1.2.1 Site Setting/Potentially Complete Exposure Pathways

The JW facility is an inactive former wood-treating facility located in a residential/industrial area of Granite City, with private residences located adjacent to the site along the west boundary. The site is fenced; however, evidence of trespassing (i.e., beer cans, graffiti, and other debris) has been observed in buildings at the facility. The site topography is relatively flat, with surface runoff towards the northeast from areas north of 22nd Street. Runoff appears to be contained at the site in areas south of 22nd Street. Bare soil areas exist at the site, but more than half of the site is covered by buildings or with grass, brush, or gravel. As stated in Section 2, five buildings, two silos, and several concrete sumps, pits, and debris piles are present on the site. Although a number of private and/or industrial wells have been identified in the area, domestic water for the Granite City area is obtained from the Mississippi River.

As discussed in Section 2, past site practices have resulted in leakage/spillage of chemicals to surface soils, or, in the case of the Jennite pit, direct deposition of wastes into soil. Once released to the soil, contamination migrated to subsurface soils and groundwater. Contamination detected at the site includes VOCs, SVOCs, pesticides, and dioxins/furans.

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Potentially complete exposure pathways and their rationale for inclusion in the SRE are listed in Table 3-2, and are presented schematically in Figure 3-1, the conceptual site model. In general, four elements must be present for a pathway to be considered as potentially complete:

- A source of chemicals and a mechanism of chemical release;
- An environmental transport medium and/or mechanism of contaminant transfer from one medium to another;
- An exposure point; and
- an intake route.

Under current conditions, potential receptors include people who may trespass on the site and nearby residents. Site visitors may be exposed to contaminants in surface soil by direct contact (i.e., ingestion and dermal contact), and by inhalation of vapors and particulates from soil at the site. Nearby residents may be exposed to vapors or particulates released from contaminants in site soil. Groundwater ingestion by nearby residents is not considered to be a complete pathway because drinking water in the area is obtained from the Mississippi River.

Future uses of the site are anticipated to be industrial. The site has a history of industrial use, and the adjacent railways make the property a desirable location for industrial redevelopment. It is anticipated that deed restrictions will be implemented to prohibit residential use of the site. Under a future industrial/commercial use scenario, site workers could be exposed to contaminants in soil via direct contact and inhalation of vapors and particulates. It is assumed that future site workers may be exposed to a combination of surface and subsurface soil that has been mixed during site redevelopment. Ingestion of contaminants in groundwater was also evaluated for site workers, despite the fact that drinking water is obtained from the Mississippi River, in the unlikely event that a drinking water well is installed at the site in the future.

Redevelopment would likely include construction excavation. Under the future construction scenario, construction workers could be exposed to contaminants in surface and subsurface soil via direct contact and inhalation of vapors and particulates. Future nearby residents may be exposed to vapors and particulates from contaminants in surface soil and excavated subsurface soil used as general fill across the site. In addition, nearby residents could be exposed to slightly higher levels of airborne contaminants during soil disturbance for construction.

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In summary, the potentially complete exposure pathways under the current conditions include:

- Direct contact with COPCs in soil and inhalation of vapors and particulates from COPCs in soil for site visitors; and
- Inhalation of vapors and particulates from COPCs in soil by nearby residents.

Potentially complete pathways under potential future conditions include:

- Direct contact with COPCs in surface and subsurface soil and inhalation of vapors and particulates from COPCs in surface and subsurface soil for future site workers (permanent workers and construction workers); and
- Inhalation of vapors and particulates from COPCs in soil by nearby residents.

3.1.2.2 Quantification of Exposure

This section describes the rationale used to determine quantitative exposure estimates. First, the methodology for deriving exposure point concentrations is presented. Secondly, the exposure estimation equations are presented along with the rationale for the selection of input parameters for the equations.

EPCs
exposure point
concentrations

UCL
upper confidence limit
on the mean

Exposure Point Calculations

The exposure media of concern for quantitative evaluation in this SRE are soil (surface and subsurface), air, and groundwater. Exposure point concentrations (EPCs) for soil and groundwater were estimated directly from measured concentrations. In accordance with EPA guidance (EPA 1992f), the data sets were statistically evaluated using a W-test (Gilbert 1987) to determine if they best fit a normal or lognormal distribution, and then the appropriate values (i.e., actual or log-transformed) were used to calculate the EPCs. The EPCs for surface soil were based on the lower of the 95% upper confidence limit on the mean (UCL) and the maximum detected value from samples collected for CLP and ASC analysis. For the future site worker and construction worker scenarios, UCLs were calculated for the combined surface and subsurface soil data, based on the assumption that these receptors would be exposed to a mixture of these soils as a result of site redevelopment. Upon review of the groundwater data, four discrete areas of groundwater contamination were identified based on the processes that occurred in certain areas of the site. Consequently, E & E segregated the groundwater data based on the proximity of the wells to the four functional areas (22nd Street Lagoon, Area H, Jennite Pit, and the PCP process area), and

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evaluated each of the areas separately. The lower of the UCL or the maximum detected value for each area was selected as the EPC for the particular chemical for each area. For air pathways, airborne concentrations of chemicals were estimated from surface and subsurface soil samples using standard mass flux calculations. EPCs calculated for the JW site are shown on Table 3-3.

Exposure Estimation Methods

The exposure estimates described in this section combine the following:

- Estimates of exposure media contaminant concentrations;
- Estimates of contact rate and frequency, and the duration of exposure that receptor populations are likely to experience; and
- Estimates of various physiological parameters (e.g., body weight, average life expectancy).

The equations used to estimate the exposure for each pathway and route of exposure evaluated in this HHRE are presented in Tables 3-4 through 3-17. The parameter values used in the equations and the rationale for their selection are also provided.

RME
reasonable maximum
exposure

Parameter values were selected to correspond to a reasonable maximum exposure (RME) that an individual in the receptor group might experience. Standard default exposure factors from EPA's *Supplemental Guidance: Standard Default Exposure Factors* (EPA 1991), TACO (IPCB 1997), or values recommended in the *Exposure Factors Handbook* (EPA 1996a) were used. Exposure factors not specified in guidance documents were based on professional judgment. Exposure to COPCs in soil, air, and groundwater was evaluated for the following scenarios:

- Scenario 1 - Current Site Visitor (soil and air exposure);
- Scenario 2 - Current Nearby Residents (air exposure);
- Scenario 3 - Future Permanent Site Worker (soil and air exposure);
- Scenario 4 - Future Permanent Site Worker (groundwater ingestion);
- Scenario 5 - Future Site Construction Worker (soil and air exposure);
- Scenario 6 - Future Nearby Residents (chronic air exposure); and

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- Scenario 7 - Future Nearby Residents (short-term air exposure during construction).

A description of the parameters used in the exposure estimation is presented below for each scenario. Because some scenarios include several pathways of exposure, all of the parameters for the first exposure route will be described and discussed in the text; for subsequent routes only the key parameters for that route and parameters not previously mentioned will be described.

Scenario 1 - Current Site Visitor

Pathway 1a: Incidental Ingestion of On-Site Soil

IR
Ingestion rate

mg/day
milligrams per day

FI
fraction of soil ingested
from the contaminated
source

EF
exposure frequency

ED
exposure duration

The ingestion rate (IR) is the amount of soil that a person might incidentally ingest through hand-to-mouth contact. The current site visitor is assumed to be an adolescent trespasser between the ages of 8 and 16 years old; therefore, the default value for age groups above 6 years old (100 milligrams per day [mg/day]) was used.

The fraction of soil ingested from the contaminated source (FI) is the estimated proportion of total soil ingested from the contaminated source. No default values exist for this variable. EPA (1991) recommends that estimates of FI be made on site-specific information, or, in the absence of specific information, best professional judgment. For this assessment, it was assumed that all of the ingested soil came from on-site soil.

For site visitors, an exposure frequency (EF) of 43 days was estimated from activity pattern data presented in EPA's *Exposure Factors Handbook* (EFH; EPA 1997b). The composite activity assessed by the EFH that was used to estimate the number of days spent at the site was *days spent outdoors - sidewalk, street, or neighborhood*. The data are reported separately by age group (1-4, 5-11, 12-17, and 18-64). The EF was estimated by averaging the number of days spent outdoors on the sidewalk, street, or in the neighborhood for three years in the 5-11 age group (39 days per year) and for five years in the 12-17 age group (46 days per year).

The exposure duration (ED) is the total number of years in which exposure is expected to occur. An ED of 8 years was used in the exposure estimate to correspond to the age range assumed for a site visitor (i.e., 8 to 16).

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BW
body weight

kg
kilograms

AT
averaging time

ABS
absorption factor

AF
adherence factor

mg/cm²
milligrams per square
centimeter

SA
surface area

cm²
square centimeters

IR_{air}
inhalation rate

m³/day
cubic meters per day

m³/hr
cubic meters per hour

The body weight (BW) is the average body weight over the exposure period. An average BW of 42 kilograms (kg) was determined for site visitors by averaging the mean BW of males aged 8 to 16 (EPA 1989).

The averaging time (AT) selected is dependent on the type of toxic effect being evaluated. For non-cancer effects, the AT is equal to the ED. For cancer effects, the exposure is averaged over a lifetime (estimated 70 years) (EPA 1989).

Pathway 1b: Dermal Contact with Soil

The absorption factor (ABS) is the rate of absorption of a chemical through the skin from the environmental medium. Chemical-specific ABSs used in the SRE are presented in Appendix I.

The soil to skin adherence factor (AF) is the fraction of soil that will adhere to the skin surface following contact. The default upper-bound value of 1 milligram per square centimeter (mg/cm²) per event (EPA 1992c) was used for the RME exposure scenario.

The skin surface area (SA) available for contact was estimated based on data presented in the EFH (EPA 1997a). The traditional default approach to estimating SA assumes that 25% of the total surface area of the body is available for contact with soil; however, the EFH suggests that refinements of the default of 25% of the total surface area can be made on the basis of seasonal conditions. The example given in the EFH for moderate climates indicates that it may be reasonable to assume 25% of the total body surface area to be exposed during the summer months, and 10% for the spring and fall months. In this assessment, the SA of 2,458 square centimeters (cm²) per event for the adolescent site visitor/trespasser was estimated by averaging the 95th percentile of the total body surface area for boys aged 8 to 16, and then averaging 25% of the average total surface area for exposure during the summer months, with 10% of the average total surface area for the spring and fall months when receptors are expected to wear more clothing, such as long-sleeved shirts, jackets, and long trousers.

Pathway 1c: Inhalation of Vapors and Particulates from Soil

The inhalation rate (IR_{air}) of 1.5 cubic meters per day (m³/day) is based on the inhalation rate for light activity (1.0 cubic meters per hour [m³/hr]) recommended by EPA (1997a) times the assumed duration of a site visit (1.5 hours per day).

The volatilization factor (VF) is a chemical-specific value used to define the relationship between concentrations of volatile COPCs in soil and volatilized COPCs in air (Smucker 1996). The equations and input parameters used in the calculation of the VF as

VF
volatilization factor

PEF
particulate emission
factor

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well as calculated VF are shown in Appendix I, Tables I-6, I-7, and I-8.

The particulate emission factor (PEF) relates the COPC concentration in soil with the concentration of respirable particles in the air due to fugitive dust emissions from sites with surface soil contamination (IPCB 1997). Based on site observations, E & E assumed that the site is approximately 10% vegetated for the calculation of the PEF. The equations and input parameters used in the calculation of the PEF are shown in Appendix I, Table I-9.

Scenario 2 - Current Nearby Residents

Inhalation exposures were estimated for both a child and an integrated child/adult receptor. The recommended IR_{air} of $8.3 \text{ m}^3/\text{day}$ and $15.2 \text{ m}^3/\text{day}$, respectively, was used for children and adult nearby residents (EPA 1997a). A default ED of 6 years was used for the child receptor and 24 years was used for an adult. The average BW for a child aged 1 to 6 (15 kg) was used for the child portion of exposure, and the default average BW for an adult male (70 kg) was used for adult exposure.

Scenario 3 - Future Permanent Site Worker

Pathway 3a: Incidental Ingestion of On-Site Soil

The default IR of 50 mg/day was used to represent a typical commercial/industrial worker, with a low degree of soil contact. The EF of 250 days per year represents a typical work year, including 2 weeks off for vacation. The ED was assumed to be 25 years (the 95th percentile amount of time working at a single location) (EPA 1991). The average BW for an adult male (70 kg) was used for all of the site worker scenarios.

Pathway 3b: Dermal Contact with Soil

The SA for a site worker was assumed to be 25% of the total body area for adult males ($5,000 \text{ cm}^2$, roughly equal to the area of the head, hands, forearms, and lower legs).

Pathway 3c: Inhalation of Vapors and Particulates from Soil

The IR_{air} of $10.4 \text{ m}^3/\text{day}$ was estimated based on the mean hourly average inhalation rate reported in the EFH for outdoor workers ($1.3 \text{ m}^3/\text{hr}$) (EPA 1997a). The average inhalation rate was selected instead of the default worker inhalation rate of $20 \text{ m}^3/\text{day}$ because the use of $20 \text{ m}^3/\text{day}$ as an inhalation rate correlates to a worker performing heavy activities for the entire workday, whereas it is more reasonable to expect that workers will engage in a mixture of slow, moderate, and heavy activities during the course of the workday.

L
liter

RfD
reference dose

Scenario 4: Future Permanent Site Worker Ingestion of

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Groundwater

The ingestion rate of 1 liter (L) of water per day was used to represent potential worker water consumption from a hypothetical site well. This value is the standard default rate of water ingestion for a hypothetical worker.

Scenario 5: Future Site Construction Worker

Pathway 5a: Incidental Ingestion of On-Site Soil

An IR of 480 mg/day was used to represent a typical construction worker, with a high amount of soil contact (EPA 1997a). The EF of 48 days per year is based on the assumption that construction at the site would last approximately 2 months with one day off per week.

Pathway 5b: Dermal Contact with Soil

The SA for a site worker was assumed to be 25% of the total body area for adult males (5,000 cm²).

Pathway 5c: Inhalation of Vapors and Particulates from Soil

The IR_{air} of 10.4 m³/day was used (as discussed in Pathway 3c).

Scenario 6: Future Nearby Residents

Future nearby residents were assessed for the same exposure pathways used for current residents in Scenario 2, but the exposure point concentrations were derived using a mixture of surface and subsurface soil, assuming that excavated soils are spread across the site as general fill.

Scenario 7: Future Nearby Residents During Construction

Exposure to future residents was also evaluated for the assumed period of construction. The parameters used were similar to those used for Scenario 6, with the exception of the PEF. The PEF for construction was used for this scenario to account for the increased amount of soil disturbance and dust development that would be expected during construction activities (IPCB 1997).

3.1.2.3 Assessment of Lead Child Lead Exposure

Potential health risks from lead cannot be assessed in the usual manner because EPA has not developed toxicological indices for lead. EPA considers the development of a reference dose (RfD) to be inappropriate because no threshold has been established for the most sensitive non-cancer effects of lead in infants and young children (see Appendix I2 for further discussion of lead toxicity). EPA has instead developed an integrated exposure uptake/biokinetic (IEUBK) model to assess blood lead dose-response relationships in children living in lead-contaminated areas. The

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model employs exposure and biokinetic algorithms to predict blood lead levels in young children (ages 0 months to 84 months) as a function of the concentrations of lead in several exposure media (soil, air, water, diet, dust, and paint [EPA 1994a]). Although the most likely site trespasser is assumed to be an adolescent between the ages of 8 and 16, a child trespasser (5 to 7 years old) was included in this risk assessment in order to evaluate potential lead exposure to the most sensitive potential receptor group (young children).

IEUBK
integrated exposure
uptake/biokinetic

GI
gastrointestinal

GM
geometric mean

GSD
geometric standard
deviation

Except for lead in air, most environmental lead enters the body via ingestion and absorption through the gut. Dermal uptake of lead is believed to be minimal; consequently, dermal exposure is not evaluated in the IEUBK model. The model consists primarily of the following components:

- An exposure/intake model that relates lead concentrations in the environmental exposure media to age-dependent intake of lead in the lungs and gastrointestinal (GI) tract;
- An absorption/uptake model that estimates the absorption and uptake of lead from the GI tract and lungs into the blood; and
- A biokinetic model that estimates the transfer of lead between the blood and various other organ and tissue compartments in the body.

The distribution of blood lead levels in a population is approximately log-normal and is defined by its geometric mean (GM) and geometric standard deviation (GSD). Using the predicted mean and an estimated GSD, the model calculates a frequency distribution for blood lead levels. The frequency distribution is then used to estimate the percentage of the population, or the probability of an individual, having a blood lead level exceeding a target concentration.

The model assumes a linear relationship between absorbed lead and blood lead at uptake levels ranging from 10 to 100 micrograms of lead per day. It is designed to evaluate relatively long-term, stable exposures; it cannot be used to evaluate rapidly changing exposures or short-term exposures of only a few days or weeks. The model is intended to be used to evaluate lead exposure at individual residential dwellings; however, it can be extended to evaluate nearby play areas by using time-weighted average soil and dust lead concentrations (EPA 1998). For a more detailed description of the model, see the *Guidance Manual for the IEUBK Model for Lead in Children* (EPA 1994a).

EPA has developed default values for model input variables

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(exposure concentrations and other exposure/uptake parameters) that reflect the current scientific consensus of the mean or median value for each parameter, rather than an upper-bound estimate. Model default values were used in this risk assessment for all of the parameters except the lead concentrations in soil and house dust.

When the IEUBK model is applied to a residential exposure setting, the soil lead concentration used in the model is typically the lead concentration measured in soil samples from a residential yard or an area that may become a residential yard in the future. The dust lead concentration used can be the measured concentration of lead in house dust, or if that information is not available, it can be assumed to be equal to 70% of the soil lead concentration. This is based on the assumption that 70% of house dust is derived from yard soil that has been tracked into the house by residents and pets, or has blown in through doors and windows. It also assumes that 45% of the total soil/dust ingested is soil, and that the remainder is house dust.

In this assessment, the IEUBK model is used to estimate the lead exposure of young children who visit the site occasionally, but spend the rest of their time outdoors, at home, or at other locations where the soil lead concentration is equal to the model's default background concentration of 200 mg/kg. Therefore, the soil lead concentration to which the child is effectively exposed is the weighted-average of the soil lead concentration at the site and the default background concentration, weighted in proportion to the time spent in each area. Contaminated soil from the site also might be carried back to the child's residence on shoes, clothing, and by pets, and be incorporated into the house dust. Therefore, the lead concentration in house dust was assumed to be equal to 70% of the time-weighted average soil concentration. The model's default assumption that 45% of the total soil/dust ingested by the child is soil and that the remainder is house dust was retained.

The amount of time a child might spend at the site was estimated from the activity pattern data provided in the EFH (EPA 1997b). The composite activity assessed in the EFH that appears to be most relevant to the time spent at the site is time spent outdoors *on a sidewalk, street, or in the neighborhood*. The time-weighting factor was used to calculate a weighted average soil lead concentration. The IEUBK model assumes that soil is ingested while the child is outdoors; therefore, the weighting factor should be the fraction of time spent outdoors, that might be spent at the site. The fraction of days on which the child might visit the site (exposure frequency at site [EF_{Site}]) was calculated as the fraction of time spent outdoors, *on a sidewalk, street, or in the neighborhood* divided by the fraction of time spent outdoors,

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EF_{Site}
exposure frequency at
site

F_{Site}
fraction at site

µg/g
micrograms per gram

PbS_{Site}
Exposure point lead
concentration at an
exposure unit on the site

outside the residence. Furthermore, on days when the child does visit the site, he or she is not likely to spend all of his or her outdoor time at the site. The fraction of the day a child might spend at the site (F_{Site}) was calculated by dividing the mean number of minutes spent outdoors, *on a sidewalk, street, or in the neighborhood*, by the mean number of minutes spent outdoors, *outside the residence.* Overall, the weighted average soil lead concentration to which a neighborhood child, who visits the site occasionally, might be exposed was calculated as follows:

where:

PbS_w = Time-weighted average soil lead concentration (micrograms per gram [$\mu\text{g/g}$]);

EF_{Site} = Exposure frequency at site, or fraction of the days/week site is visited during the exposure period (dimensionless);

F_{site} = Fraction of daily outdoor time spent at the site on days when the site is visited (dimensionless);

PbS_{Site} = Exposure point lead concentration at an exposure unit on the site ($\mu\text{g/g}$);

F_{yard} = Fraction of daily outdoor time at local background soil lead level (usually near home) = $1 - EF_{\text{Site}}$;

PbS_{Yard} = Average soil lead concentration near home (IEUBK model default background soil lead concentration of 200 $\mu\text{g/g}$ was assumed); and

EF_{Yard} = Fraction of the days/week child does not visit the site during the exposure period = $1 - EF_{\text{Site}}$.

For this assessment, it was assumed that the most likely child trespasser would be within the upper age limit evaluated by the model (i.e., the 5- to 7-year-old age group).

Children were assumed to be exposed to model default background levels of soil and dust lead from 0-5 years of age. From 5-6 and 6-7 years of age, children were assumed to be exposed to the weighted average soil lead concentrations, calculated based on the activity patterns reported in the EFH for the 5- to 11-year-old age group (see Table 3-16), and dust lead concentrations equal to 70% of the weighted average soil concentration. The default

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assumptions for total amount of soil and dust ingested by a child in each 12-month age bracket were not adjusted. PbS_{Site} values were equal to the sitewide average and the maximum detected concentrations of lead in surface soil. The estimated weighted average soil concentrations are presented in Table 3-16. The estimated geometric mean blood lead concentrations and the percent of the population, or likelihood of an individual, having a blood lead level greater than 10 micrograms per deciliter ($\mu g/dl$), are presented in Table 3-22. All of the parameter values used in the IEUBK model runs and graphs of the predicted blood lead levels for each scenario are provided in Appendix I.

Adult Lead Exposure

Most often, assessments of lead exposure at Superfund sites have been performed for children rather than for adults because a typical child's activity patterns make them more likely to be exposed to lead in soil and dust, and because children are more sensitive to the toxic effects of lead than are adults. However, at the Jennison-Wright site, adult workers are considered to be the primary potential future receptors. The IEUBK model is not the appropriate method for assessment of lead exposure to adults.

Potential exposure of adult workers to lead-contaminated soils and dust was evaluated in this HHRE using a screening method developed by EPA (1996b) that is similar to a predictive biokinetic uptake model developed by Bowers et al. (1994). The model uses medium-specific ingestion and absorption parameters and a biokinetic slope factor that relates uptake of lead into the body to blood lead levels. The model calculates a cleanup concentration for lead in soil based on potential lead exposures to pregnant women or women of child-bearing age in the workplace.

The modified equation used in the screening program is as follows:

where:

- C_s = Target soil lead cleanup concentration (micrograms per gram [$\mu g/g$]);
- $PbB_{fetal, 0.95}$ = The 95th percentile fetal blood lead level ($\mu g/dl$);
- R = The ratio of blood lead in fetal blood to maternal blood (unitless);
- GSD_i = The geometric standard deviation of maternal blood lead levels (unitless);

$PbB_{fetal, 0.95}$
The 95th percentile fetal blood lead level
micrograms per deciliter

R
The ratio of blood lead in fetal blood to maternal blood (unitless)

GSD_i
The geometric standard deviation of maternal blood lead levels

PbB_0
Baseline blood lead value in women not occupationally exposed to lead

BKSF
Biokinetic slope factor

IR_{s+d}
Soil and dust ingestion rate

AF_s
Absolute absorption fraction of lead in soil

W_s
Weighting factor; fraction of IR_{s+d} ingested as outdoor soil

K_{sd}
Ratio of lead concentration in dust to that in soils

AF_d
Absolute absorption fraction of lead in dust

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PbB_0	= Baseline blood lead value in women not occupationally exposed to lead ($\mu\text{g/dl}$);
AT	= Averaging time; the total period during which soil contact may occur (365 days per year for continuing long-term exposures);
BKSF	= Biokinetic slope factor ($\mu\text{g/dl}$ per $\mu\text{g/day}$);
IR_{s+d}	= Soil and dust ingestion rate (g/day);
AF_s	= Absolute absorption fraction of lead in soil (unitless);
EF_s	= Soil exposure frequency (days/yr);
W_s	= Weighting factor; fraction of IR_{s+d} ingested as outdoor soil (unitless);
K_{sd}	= Ratio of lead concentration in dust to that in soils;
IR_d	= Dust ingestion rate (g/day);
AF_d	= Absolute absorption fraction of lead in dust (unitless); and
EF_d	= Dust exposure frequency (days/yr).

Values used in the calculation of target lead levels in soil are presented in Table 3-17. A detailed discussion of all of the parameters used in the model is presented in EPA (1996b). A brief discussion of some of the key parameter values used in the model is presented below.

Target Mean Blood Lead Level for the Fetus ($PbB_{\text{fetal}, 0.95}$)

The target blood lead level for the fetus is the goal for the 95th percentile blood lead concentration among fetuses born to women having exposures to the specified site soil concentration. This means that there is a 95% likelihood that a fetus, in a woman who experiences such exposures, would have a blood lead concentration no greater than $PbB_{\text{fetal}, 0.95}$. The value of 10 $\mu\text{g/dl}$ used for $PbB_{\text{fetal}, 0.95}$ is based on Office of Solid Waste and Emergency Response (OSWER) guidance, which sets a goal to limit the risk of childhood blood lead levels above 10 $\mu\text{g/dl}$ to 5%.

OSWER
Office of Solid Waste
and Emergency
Response

BKSF
biokinetic slope factor

Fetal/Maternal Blood Lead Concentration Ratio (R)

The default value of 0.9 recommended by EPA (1996a) and used in this assessment is based on studies exploring the relationship between fetal and maternal blood lead levels.

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Baseline Blood Lead Concentration (PbB_0)

This value represents the best estimate of a reasonable central value of blood lead concentration in women of child-bearing age who are not exposed to lead-contaminated non-residential soil or dust at the site. The model uses the geometric mean blood lead concentration. In lieu of site-specific data, EPA (1996b) recommends 1.7 to 2.2 $\mu\text{g}/\text{dl}$ as a plausible range for PbB_0 . The low value in the range is representative of non-Hispanic white women, while the high end represents non-Hispanic black women. The high value (2.2 $\mu\text{g}/\text{dl}$) was used in this assessment in order to be protective of the most sensitive potential receptor in the group.

Individual Geometric Standard Deviation (GSD_i)

The GSD_i is a measure of the variability among individuals in blood lead concentrations in a population whose members are exposed to the same non-residential environmental lead levels. Due to the lack of data on women living in the vicinity of the site, E & E used the upper end of the range of credible values estimated by EPA (1996b). The GSD_i of 2.1 was selected to reflect a potentially diverse population with respect to racial, ethnic, cultural, and/or socioeconomic makeup.

Biokinetic Slope Factor

The biokinetic slope factor (BKSF) relates uptake of lead into the body to blood lead levels. BKSFs for adults have not been directly measured; however, estimates of BKSFs range from 0.3 to 0.5 for adults. The default BKSF of 0.4 was used in the model.

Ratio of Concentration in Dust to That in Soil (K_{sd})

Workers at the site may be exposed to lead in both soil and indoor dust; however, site-specific data identifying the ratio of lead concentrations in soil to those in dust are not available. A value of 70% was used for K_{sd} in the model. This value is consistent with the value used in the IEUBK model for the contribution of lead in soil to lead in dust.

Soil and Dust Ingestion Rate (IR_{s+d})

The default soil ingestion rate for non-contact intensive occupations specified in EPA guidance (0.05 g/day) was used for workers at the site (EPA 1991b). A weighting factor (W_s) of 1 was used in the model assuming that all of the soil and dust is ingested as outdoor soil.

Absolute Absorption Fraction of Lead in Dust and Soil (AF_d and AF_s)

The recommended default value of 0.12 was used for both AF_d and AF_s . This value is based on an estimated absorption factor of 0.2 for soluble lead times the estimated relative bioavailability of lead in soil of 0.6 (EPA 1996b).

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The results of the lead evaluation are discussed in Section 3.1.4.2.

3.1.3 Toxicity Assessment

The purpose of the toxicity assessment is to review toxicity and carcinogenicity data for the COPCs, and to provide an estimate of the relationship between the extent of exposure to these contaminants and the likelihood and/or severity of adverse effects. The toxicity assessment is accomplished in two steps: hazard identification and dose-response assessment.

The hazard identification is a qualitative description of the potential toxic effects of the COPC. The health effects summaries presented in Appendix I describe the toxic effects that have been observed in humans and/or animals following exposure to the COPCs identified at the JW site.

SF
slope factor

The dose-response evaluation is a process that results in a quantitative estimate or index of toxicity for each COPC at the site. For carcinogenic effects, the index is the slope factor (SF), and for noncarcinogenic effects, it is the RfD. Practices and procedures used to develop quantitative indices of toxicity and to incorporate toxicological information into the risk estimation process, as well as the quantitative indices of toxicity are presented below.

3.1.3.1 Quantitative Indices of Toxicity

Quantitative indices of toxicity were compiled for the dose-response assessment to be used in estimating the relationship between the extent of exposure to a contaminant and the potentially increased likelihood and/or severity of adverse effects. The methods for deriving indices of toxicity and estimating potential adverse effects are presented below. The indices of toxicity for the COPCs are presented in Tables 3-16 and 3-17, respectively, for carcinogenic and noncarcinogenic effects.

Categorization of Chemicals as Carcinogens or Noncarcinogens

For the purpose of this risk evaluation, COPCs were classified into two groups: potential carcinogens and noncarcinogens. The risks posed by these two types of compounds are assessed differently because noncarcinogens generally exhibit a threshold dose, below which no adverse effects occur, while no such threshold has been proven to exist for most carcinogens.

As used here, the term "carcinogen" means any chemical for which there is sufficient evidence that exposure may result in continuing uncontrolled cell division (cancer) in humans and/or animals. Conversely, the term "noncarcinogen" means any chemical for which the carcinogenic evidence is negative or insufficient. These classifications are dynamic; chemicals may be reclassified any time

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additional evidence becomes available that shifts the weight-of-evidence one way or the other.

COPCs have been classified as carcinogens or noncarcinogens based on weight-of-evidence criteria contained in the EPA *Guidelines for Carcinogen Risk Assessment* (EPA 1986). Table 3-18 summarizes the five EPA weight-of-evidence categories. According to EPA guidelines, chemicals in Groups A and B (B1 or B2) are considered human carcinogens or probable human carcinogens based on sufficient evidence, and should be the subject of non-threshold carcinogenic risk estimation procedures. Depending upon the quality of the data, Group C chemicals may also be subjected to these procedures. Chemicals in Groups D and E are considered noncarcinogens and should be subjected to threshold-based toxicological risk estimation procedures.

Exposure to some chemicals may result in both carcinogenic and noncarcinogenic effects. In these cases, both the carcinogenic and noncarcinogenic effects were evaluated and considered in the risk evaluation process.

Assessment of Carcinogens

In contrast to noncarcinogenic effects, for which thresholds are thought to exist, scientists generally have been unable to demonstrate experimentally a threshold for carcinogenic effects. This has led to the assumption by federal regulatory agencies (e.g., EPA, Food and Drug Administration [FDA], and Occupational Safety and Health Administration [OSHA]) that any exposure to a carcinogen theoretically entails some finite risk of cancer. However, depending on the potency of a specific carcinogen and the level of exposure, such a risk could be minute.

Scientists have developed several mathematical models to estimate low-dose carcinogenic risks from observed high-dose risks. Consistent with current theories of carcinogenesis, EPA has selected the linearized multistage model based on prudent public health policy (EPA 1986). In addition to using the linearized multistage model, EPA uses the upper 95th percentile confidence limit for doses or concentrations in animal or human studies to estimate low-dose SFs. By using these procedures, the regulatory agencies are unlikely to underestimate the actual SFs (formerly called carcinogenic potency factors) for humans.

Using SFs, lifetime excess cancer risks can be estimated by:

$$\text{Risk} = \sum \text{LADI}_j \times \text{SF}_j$$

FDA
Food and Drug
Administration

OSHA
Occupational Safety and
Health Administration

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where:

$LADI_j$ = Exposure route-specific lifetime average daily intake; and

SF_j = Route-specific slope factor.

Using the multistage model, the carcinogenic risks for the oral, dermal, and inhalation routes of exposure are calculated as follows:

$$\text{Risk} = LADI_o SF_o + LADI_d SF_d + LADI_i SF_i$$

where subscript "o" indicates the oral route, subscript "d" the dermal route, and subscript "i" the inhalation route. SFs for the COPCs for the oral and inhalation exposure routes are presented in Table 3-16. EPA's weight-of-evidence classification for the chemical and the type of cancer that may be associated with exposure to the chemical are also included in Table 3-16.

Assessment of Noncarcinogens

Risks associated with non-cancer effects (e.g., organ damage, immunological effects, birth defects, skin irritation) are usually assessed by comparing the estimated average exposure to the acceptable daily dose, called the RfD by EPA. The RfD is selected by identifying the lowest reliable no observed adverse effect level (NOAEL) or lowest observed adverse effect level (LOAEL) in the scientific literature, then applying suitable uncertainty factors (which often range from 1 to 10) to allow for differences between the study conditions and the human exposure situation to which the RfD is to be applied. NOAELs and LOAELs can be derived from either human epidemiological studies or animal studies; however, they are usually based on laboratory experiments on animals in which relatively high doses are used. Consequently, uncertainty or safety factors are applied when deriving RfDs to compensate for data limitations inherent in the underlying experiments and for the lack of precision created by extrapolating from high doses in animals to lower doses in humans. The application of uncertainty factors in the derivation of RfDs is explained in RAGS (EPA 1989) as follows:

NOAEL
no observed adverse
effect level

LOAEL
lowest observed adverse
effect level

UFs
uncertainty factors

MF
modifying factor

mg/kg-day
milligrams per kilogram
per day

The RfD is derived from the NOAEL (or LOAEL) for the critical toxic effect by consistent application of uncertainty factors (UFs) and a modifying factor (MF). The uncertainty factors generally consist of multiples of 10 (although values less than 10 are sometimes used), with each factor representing a specific area of uncertainty inherent in the extrapolation from the available data. Uncertainty factors may be applied for the following reasons:

- To account for variation in the general population and to

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protect sensitive subpopulations (e.g., elderly, children);

- When study results are extrapolated from animals to humans, to account for the interspecies variability between humans and other mammals;
- When a NOAEL derived from a subchronic instead of a chronic study is used as the basis for a chronic RfD; and
- When a LOAEL is used instead of a NOAEL, to account for the uncertainty associated with extrapolating from LOAELs to NOAELs.

In addition to the UFs listed above, an MF ranging from >0 to 10 is applied to reflect a qualitative professional assessment of additional uncertainties in the critical study and in the entire database for the chemical not explicitly addressed by the preceding uncertainty factors. The default value for the MF is 1.

To calculate the RfD, the appropriate NOAEL (or the LOAEL if a suitable NOAEL is not available) is divided by the product of all of the applicable uncertainty factors and the modifying factor. That is:

$$\text{RfD} = \text{NOAEL or LOAEL} / (\text{UF}_1 \times \text{UF}_2 \dots \times \text{MF})$$

Oral RfDs are typically expressed as one significant figure in units of milligrams per kilogram per day (mg/kg-day). The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of the daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a portion of the lifetime, in the case of a subchronic RfD, or during the entire lifetime, in the case of a chronic RfD. The RfD is used as a reference point for gauging the potential effects of other exposures. Usually, exposures that are less than the RfD are not likely to be associated with health risks. As the frequency of exposures exceeding the RfD increases and as the size of the excess increases, the probability increases that adverse health effects may be observed in a human population. Nonetheless, a clear distinction that would categorize all exposures below the RfD as "acceptable" (risk-free) and all exposures in excess of the RfD as "unacceptable" (causing adverse effects) cannot be made. Non-cancer risks are usually assessed by calculating a hazard quotient, which is the ratio of the estimated exposure to the RfD as follows:

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where:

HQ = Hazard quotient;
CDI = Chronic daily intake (exposure); and
RfD = Reference dose (acceptable daily intake).

Hazard quotients are commonly summed across exposure routes to give a hazard index. A hazard index greater than 1 indicates that adverse effects may be possible while a value less than 1 means that adverse effects would not be expected. The higher the hazard index is above 1, the more likely it is that adverse effects could occur.

SDI
subchronic daily intake

IRIS
Integrated Risk
Information System

EPA has developed some subchronic RfDs based on potential noncarcinogenic effects associated with exposure durations ranging from a few weeks to seven years. Short-term exposures can occur when an activity resulting in exposure is performed for a limited period of time or when a chemical degrades or disperses to negligible concentrations within a short period. The hazard quotient for subchronic exposure is obtained by dividing the estimated subchronic daily intake (SDI) by the subchronic RfD.

Table 3-17 presents chronic and subchronic RfDs for the oral and inhalation exposure routes along with the degree of confidence placed on the values, critical health effects that serve as the basis of the RfDs, and descriptions of the study(ies) on which the RfD is based. The preferred source for RfDs is EPA's Integrated Risk Information System (IRIS) database, which contains confirmed values reflecting the consensus judgment of the agency (EPA 1997c). The second choice is EPA's Health Effects Assessment Summary Tables (HEAST), which contain information taken from final documents prepared by EPA's Office of Health and Environmental Assessment (EPA 1997d).

HEAST
Health Effects
Assessment Summary
Tables

GIAF
gastrointestinal
absorption factor

Route-to-Route Extrapolation of Reference Doses and Slope Factors

Once a substance has been absorbed via the oral or dermal route, its distribution, metabolism, and elimination patterns (biokinetics) are usually similar. For this reason, and because dermal route RfDs and SFs are usually not available, oral route RfDs and SFs are commonly used to evaluate exposures to substances by both the oral and dermal routes. In accordance with RAGS, when the RfD or SF is based on an administered dose, and the gastrointestinal absorption of the COPC is significantly less than 100%, the RfD or SF is adjusted to assess dermal risks using a gastrointestinal absorption factor (GIAF), which represents the oral absorption efficiency of the chemical. The RfD is multiplied by the GIAF and the SF is divided by the GIAF to obtain toxicity values based on an absorbed dose. Four of the COPCs at the Jennison-Wright site

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(beryllium, chromium, manganese, and 2,3,7,8-TCDD) had GIAFs significantly less than 1 (i.e., 100% absorption). GIAFs used in this risk assessment are presented in Appendix I, Table I-5. Although inhalation route biokinetics differ more from oral route kinetics than do the dermal route kinetics, oral RfDs and SFs may also be used to evaluate inhalation exposures if inhalation route RfDs and SFs are not available, and vice versa. Extrapolation of toxicological indices from one route to another is inappropriate if the critical effect for either route is at the point of contact.

Assessment of Lead

There are no verified or EPA consensus toxicological indices available for lead in either IRIS or HEAST. As discussed in Section 3.1.2.3, the evaluation of lead was conducted using biokinetic uptake models.

3.1.4 Risk Characterization

This section combines information developed in the exposure and toxicity assessment sections (sections 3.1.2 and 3.1.3) to obtain quantitative estimates of potential risks to human health posed by COPCs at the JW site. It also compares those estimates with risk levels deemed acceptable by EPA. Section 3.1.4.1 briefly describes the process for estimating potential carcinogenic and noncarcinogenic risks and Section 3.1.4.2 presents the risk estimates and summarizes the major site risks.

3.1.4.1 Risk Estimation Procedures

The following subsections review the processes for quantitatively estimating carcinogenic and noncarcinogenic risks and discuss the levels of risk regarded as acceptable under current EPA policy.

Carcinogenic Risk Estimation

Potential cancer risks are assessed by multiplying the estimated lifetime average daily intake (LADI) of a carcinogen by its SF. This calculated risk is expressed as the probability of an individual developing cancer over a lifetime and is an estimated upper-bound incremental probability. Cancer risks initially are estimated separately for exposure to each chemical for each exposure pathway and receptor category (i.e., adult or child). Separate cancer risk estimates then are summed across chemicals, receptors, and all exposure pathways applicable to the same population to obtain the total excess lifetime cancer risk for that population. Cancer risk estimates are provided in scientific notation; 1×10^{-6} is equivalent to $1E-6$, which equals 0.000001.

Federal environmental laws and regulations recognize that estimates of very small levels of risk are insignificant. The concept of *de minimis* risk refers to a level below which risks are so small that they are not of concern. Government agencies regard

LADI
lifetime average daily
intake

NPL
National Priorities List

CDI
chronic daily intake

HQ
hazard quotient

HI
hazard index

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cancer risks less than 1×10^{-6} as *de minimis* and consider risks between 1×10^{-6} and 1×10^{-4} to be within a generally acceptable range. These regulatory risk levels have been adopted by the EPA Superfund program. Under current EPA Superfund policy, as stated in the NCP (EPA 1992a), acceptable exposures to known or suspected carcinogens are generally those that represent an excess upper-bound lifetime cancer risk to an individual of between 1×10^{-4} and 1×10^{-6} . In addition, the EPA uses the 1×10^{-6} risk level as the point of departure for determining remediation goals for National Priorities List (NPL) sites (EPA 1992d).

Noncarcinogenic Risk Estimation

The potential for adverse effects resulting from exposure to a noncarcinogen is assessed by comparing the estimated chronic daily intake (CDI) or SDI of a substance to its chronic or subchronic RfD. This comparison is made by calculating the ratio of the estimated CDI or SDI to the corresponding RfD to yield a hazard quotient (HQ). HQs that are associated with similar critical effects (e.g., liver damage) should be summed together to obtain a hazard index (HI) for that effect, whereas HQs for different critical effects should be kept separate. However, for screening purposes, HQs are commonly summed across all chemicals, exposure routes, and pathways applicable to a given population to obtain an HI for that population.

For evaluating noncarcinogenic effects, EPA defines acceptable exposure levels as those to which the human population, including sensitive subgroups, may be exposed without adverse effects during a lifetime or part of a lifetime, incorporating an adequate margin of safety (EPA 1989). This acceptable exposure level is approximated by an HI less than or equal to 1.0.

3.1.4.2 Risk Estimates

Detailed tables containing estimates of potential exposures and associated risks for the scenarios that were described in Section 3.1.2.2 can be found in Appendix I. Table 3-21 summarizes the total cancer risks and non-cancer HIs from the detailed tables in Appendix I, and shows which exposure pathways and chemicals are most responsible for the estimated risks.

The following subsections review the estimated current risks and potential future risks presented in the tables, focusing on the pathways and chemicals associated with the greatest risks.

Current Risks

Using RME assumptions, the estimated potential excess lifetime cancer risk for current site visitors from exposures to soil contaminants (Scenario 1) is 7.7×10^{-4} , due mainly to soil ingestion and dermal absorption. This risk is above the 10^{-6} -to- 10^{-4}

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range regarded as acceptable by EPA. Dioxins/furans account for 82% of the cancer risk, and PAHs account for most of the remainder. For nearby resident exposure to airborne contamination from site soils (Scenario 2), the estimated cancer risks for the integrated adult/child exposure and childhood exposure are 2.7×10^{-5} and 2.3×10^{-5} , respectively, within EPA's acceptable range. Vapor inhalation accounts for almost all of this estimated cancer risk, with approximately 76% of the risk due to dioxins/furans, 7% due to carbazole, and 6% due to PCP.

The potential risks estimated for the adolescent site visitor and the adult/child resident could apply to a single individual. If so, the total estimated cancer risk for that receptor would be 8.0×10^{-4} , (which is above the range considered acceptable by EPA) and approximately 96% of that risk would be associated with on-site soil exposures.

HI's estimated for the on-site visitor exposures and off-site adult/child resident exposure, and the total HI from both on-site and off-site exposure are below 1.0. That indicates that noncarcinogenic adverse health effects would not be expected for those receptors from exposure to site contamination under existing conditions. The HI for the nearby child resident exceeded 1, with naphthalene accounting for 90% of the risk.

Long-Term Future Site Risks

Under a future industrial/commercial land use scenario (Scenario 3), the total potential RME cancer risk associated with future site worker exposures to soil contaminants is estimated to be 1.0×10^{-2} , well above the 10^{-6} to 10^{-4} range. This estimated risk is due mostly to dermal absorption and soil ingestion. The soil contaminants most responsible for this estimated cancer risk are dioxins/furans (86%) and PAHs (approximately 12%). The HI calculated for future worker soil exposures is 0.8, indicating that adverse noncarcinogenic effects from future site worker exposure to soil contamination are unlikely to occur.

If site groundwater was used as a drinking water source for future site workers, risks from soil exposure would have to be added to risks from groundwater ingestion to obtain the worker's total potential risk. Estimates of additional worker risk from groundwater ingestion (Scenario 4) vary widely depending on the well location. At two of the four locations evaluated, the PCP Process Area and the 22nd Street Lagoon area, the estimated cancer risks are well above the 10^{-4} level and the HI's are well above 1.0, indicating that use of site groundwater from those areas might cause noncancer effects in addition to posing unacceptably high cancer risks. The highest cancer risk, 3.7×10^{-2} , was estimated for groundwater at the PCP Process Area, and is almost

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entirely due to PCP. The HI of 31.9 for groundwater use at this location is due mostly to PCP (HQ=29), arsenic (HQ=2), and manganese (HQ=1). (The individual HQ for these COPCs should not be summed together because they affect different organ systems). At the 22nd Street Lagoon location, the total estimated cancer risk for groundwater ingestion is 2.4×10^{-3} , mainly due to PAHs (41%), benzene (28%), PCP (25%) and arsenic (5%). The HI for groundwater use at this location is 46.7, with five individual chemicals having HQs greater than 1.0: benzene (HQ=21.5), 2,4-dimethylphenol (HQ=7), 2-methylphenol (HQ=4.1), manganese (HQ=1.2), and naphthalene (HQ=10.2). A review of the target organ systems of 2,4-dimethylphenol, 2-methylphenol, and manganese indicates that the HQs for these COPCs should be summed together, because they all cause neurotoxic effects. Summing the respective HQs results in an HI of approximately 12.3.

At the other two locations evaluated for groundwater ingestion by future site workers, Area H and the Jennite Pit, the estimated cancer risks are 2.0×10^{-5} and 1.8×10^{-5} , near the middle of the 10^{-6} to 10^{-4} range. The chemicals that contribute most to these cancer risks are PCP at Area H and arsenic at the Jennite Pit. HI totals for groundwater use in Area H and the Jennite Pit are less than 1.0, indicating that this exposure would not be expected to cause adverse noncancer effects.

For future exposures to nearby off-site residents from airborne contaminants following conversion of the site to industrial or commercial use (Scenario 6), the estimated RME cancer risks for integrated adult/child and childhood exposures are 2.6×10^{-5} and 2.4×10^{-5} , respectively. These estimated cancer risks are similar to the estimated risks under current conditions, and are within EPA's acceptable range. Vapor inhalation accounts for almost all of this estimated cancer risk, with approximately 79% of the risk due to dioxins/furans and 10% due to benzene. The HI for noncancer effects from future off-site inhalation exposure to the adult/child receptor was less than 1.0; however, the HI for the child resident exceeded 1 due to naphthalene (90% of risk).

Future Risks During Construction

The potential RME cancer risk estimated for construction worker exposures to soil contaminants during future site development (Scenario 5) is 2.2×10^{-4} , just exceeding the 10^{-6} to 10^{-4} range. Most of this estimated cancer risk (65.6%) is associated with soil ingestion. The chemicals most responsible for the risk are dioxins/furans (87%) and PAHs (approximately 10%). For exposures of nearby residents to airborne contaminants during future construction activities (Scenario 7), the estimated cancer risks for adults and children exposures are 1.4×10^{-5} and 3.7×10^{-5} ,

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respectively, within EPA's acceptable range. Vapor inhalation accounts for almost all of this estimated cancer risk, with approximately 79% of the risk due to dioxins/furans and 10% due to benzene.

The noncancer HI estimated for construction worker soil exposures (Scenario 5) is 43.2, mainly from the vapor inhalation route. Contributing to this total were two individual chemical HQs greater than 1.0: 40.8 for naphthalene and 1.3 for benzene. These two HQs should be summed together, giving an HI of 42.1, because benzene and naphthalene exposures are both associated with hematological effects. The HIs estimated for inhalation exposures of nearby residents during construction (Scenario 7) are also greater than 1.0, mostly due to the vapor inhalation route, with HIs of 45 and 115 for the adult and child, respectively. Again, benzene and naphthalene are the main contributors to the total HIs. For the child's vapor inhalation exposure, the HQs for benzene and naphthalene are 3.5 and 110, respectively, and the total HI for hematological effects is 113.5.

HQs above 1.0 suggest that inhalation of benzene and naphthalene during construction might cause adverse noncarcinogenic health effects in workers and nearby off-site residents. However, it should be noted that there is quite a bit of uncertainty associated with the air exposure point concentrations, which were estimated from chemical concentrations in soil. Because of the conservative method and assumptions that were used to calculate the air concentrations (see uncertainty discussion in Section 3.1.5), it is likely that the results overestimate the actual exposure that would occur. Furthermore, there is a large degree of protectiveness built into the toxicity values, which are derived from animal data by incorporating large uncertainty factors (100 for benzene and 1,000 for naphthalene). Therefore, these results probably overestimate the significance of the health hazard posed by these chemicals.

Assessment of Lead

The risks associated with lead exposure are assessed by comparing the estimated blood lead distribution in the exposed population with the target distribution established by EPA. EPA has recommended a goal of 95% of the sensitive population (in this case, children trespassing at the site, or the fetus of a woman worker at the site) having blood lead levels at or below 10 µg/dl, or in other words, the goal will result in no more than a 5% probability of an individual exceeding the 10-µg/dl goal.

The results of the IEUBK model and adult lead screening model are summarized in Table 3-22, and calculation spreadsheets are included in Appendix I. For the child trespasser scenario, the percentage of children predicted by the IEUBK model to have

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blood lead levels at or above 10 µg/dl did not exceed 5% for either estimate (i.e., using the site-wide average or maximum detected concentration). The estimated geometric mean blood lead levels were 3.4 and 3.5 µg/dl, respectively, for the site-wide average and maximum detected concentration scenarios. It should be noted that the site-wide average concentration is actually lower than the default concentration of lead in residential soil.

For the adult worker scenario, the estimated 95th percentile fetal blood lead concentration was below the 10 µg/dl target. The estimated remediation goal of 656 mg/kg lead in soil was greater than the maximum detected concentration at the site.

Given the results of modeling presented above, the detected concentrations of lead in soil at the site are not anticipated to result in unacceptable blood lead levels for children trespassing at the site, or for the unborn children of pregnant female workers at the site.

Nature of Potential Health Effects

The JW site contaminants estimated to pose potential excess lifetime cancer risks greater than 10⁻⁶ include arsenic, benzene, carbazole, dioxins/furans, carcinogenic PAHs, and PCP. Arsenic and benzene are classified under EPA weight-of-evidence category Group A, human carcinogens. Oral exposure to arsenic is known to cause skin cancer, and there is mounting evidence that arsenic may also cause liver, kidney, bladder, or lung cancer. Benzene has been shown to cause leukemia. Carbazole, dioxins/furans, carcinogenic PAHs, and PCP are classified under Group B2, probable human carcinogens, based on carcinogenicity in animals. Dioxins/furans have caused various types of tumors in exposed animals. Oral exposures to carbazole and PCP have been associated with liver cancer in animals. Benzo(a)pyrene and the other carcinogenic PAHs cause cancers primarily at the point of exposure; oral exposures are associated with stomach cancer, dermal exposures are associated with skin cancer, and inhalation exposures are associated with lung cancer.

Site contaminants that could potentially pose risks of non-carcinogenic adverse health effects include benzene and naphthalene in site soil, and arsenic, 2,4-dimethylphenol, manganese, 2-methylphenol, naphthalene, and PCP in the groundwater. Benzene is toxic to blood-forming organs and the immune system, and excessive exposure can result in anemia and a weakened immune system. Blood is also the primary target of naphthalene toxicity in humans; overexposure can cause hemolytic anemia. Long-term exposure to PCP can cause damage to the liver, blood, and central nervous system. Overexposure to arsenic can cause damage to the kidneys and blood, weight changes, and

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possible keratosis and hyperpigmentation of the skin in humans. There are no studies of long-term effects of human exposures to 2,4-dimethylphenol and 2-methylphenol. In animal studies, 2,4-dimethylphenol exposure has caused neurological effects and changes in blood chemistry, while 2-methylphenol exposure has caused neurological effects and decreased body weight. Studies suggest that ingestion of manganese can cause changes in brain chemistry; however, reports of adverse effects in humans from ingestion of manganese are rare.

Major Factors Controlling Estimated Site Risks

The major factors controlling the estimated risks for the JW site are:

- The presence of dioxins/furans and carcinogenic PAHs in site soils and potential exposures to current site visitors and future site workers;
- The presence of PCP in groundwater in the PCP process area, and the presence of carcinogenic PAHs, benzene, PCP, arsenic, 2,4-dimethylphenol, 2-methylphenol, and naphthalene in groundwater at the 22nd Street lagoon, coupled with the possible future use of groundwater as a drinking water source; and
- The presence of benzene and naphthalene in subsurface soils and the potential future short-term inhalation exposures of workers and nearby residents during periods of excavation/construction on the site.

Figures 3-2 and 3-3 each present an isopleth of estimated cancer risks posed to current site visitors and future permanent site workers based on the concentrations of COPCs detected at each individual sample location. The isopleths help to identify “hot-spots” of contamination at the site based on the estimated cancer risk. As shown on the figures, the highest estimated risks are typically associated with samples collected in the former storage and waste disposal areas.

Exposures to soil contaminants may currently be occurring and could reasonably be expected under current or expected future land-use conditions. However, the conservative (health-protective) exposure assumptions may overestimate actual exposures of the receptor populations.

There are currently no potable water supply wells in the immediate vicinity of the site. However, the presence of a few domestic wells within a 1-mile radius of the site suggests the possibility that a future business might install such a well on the site, potentially

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exposing the users to groundwater contamination. Nevertheless, future use of site groundwater seems unlikely, because there is an existing public water supply system that serves the area. Therefore the probability of exposure to site contaminants in groundwater is small.

3.1.5 Discussion of Uncertainty

The risk characterization combines and integrates the information developed in the exposure and toxicity assessments; therefore, uncertainties associated with these assessments also affect the degree of confidence that can be placed in the risk characterization results. Exposure assessment uncertainties and toxicity assessment uncertainties are described below in sections 3.1.5.1 and 3.1.5.2, respectively. Additional uncertainties, including those that result from the risk assessment process itself, are described in Section 3.1.5.3.

3.1.5.1 Uncertainty in the Exposure Assessment

A number of factors will cause the estimated exposure levels to differ from the exposures that potential receptor populations may actually experience. This section will identify these factors, discuss the potential effects of the factors on the exposure estimates, and, where possible and appropriate, estimate the degree of confidence that should be placed in the various assumptions and parameter estimates that have gone into the exposure estimates.

Environmental Sampling

To gather data that are statistically representative of the site, the sampling locations should be selected in a random or systematic fashion, usually using a grid system.

Most of the site surface soil samples (81 out of 92) collected during the EE/CA field investigation were unbiased samples from locations that were based on a systematic sampling grid. All 81 grid samples were analyzed for PAHs, while 16 of the samples were systematically selected for TCL VOC, TCL pesticide/PCB, and TAL inorganic analyses. These samples should be statistically representative of current surface soil contamination at the site.

However, the other 11 samples were biased samples intended primarily to characterize the nature and extent of contamination in various site media. Accordingly, sample locations were selected in a purposeful or directed manner to accomplish that goal. Samples collected in this manner provide considerable information about the site, but are not statistically representative of the contamination that may be present on the site as a whole. The bias associated with subsurface soil samples is probably small, even though locations were not randomly selected, because of the large number of subsurface soil samples and somewhat even distribution across

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the site. However, 11 biased surface soil samples were collected from targeted areas of known or suspected contamination, and these were the only samples analyzed for dioxins/furans in addition to the other analyses. The data from these biased surface soil samples may substantially overestimate the levels of dioxins/furans, and possibly other contaminants in soil, for the site as a whole. Groundwater monitoring well locations were selected to characterize groundwater contamination and to determine contaminant plume boundaries; therefore the contaminant levels in these wells may well represent higher-than-average levels for the site.

While some of the data are not statistically representative, there is no reason to believe that they are not typical for the areas sampled. Moderate- to large-sized data sets were used as the basis for the source concentrations for soil contamination. Because there appeared to be several groundwater contaminant plumes related to different sources on the site, four individual locations were evaluated separately to characterize the range of possible risks from groundwater use.

Analytical Result Limitations

One aspect of the analytical data that could reduce the level of confidence in the estimates of contaminant concentrations in environmental media is the inclusion of estimated results (J-flagged values) that may not have the same precision and accuracy as data meeting all of the standard quality assurance (QA) criteria. This is a very minor concern.

QA
quality assurance

For soils, PAH screening data were used in the quantitative risk evaluation. Evaluation of the data (i.e., laboratory methods, data qualifiers, and sample quantitation limits) indicated that the data were usable for quantitative risk assessment; therefore, the use of the PAH data is not expected to significantly impact the level of confidence in the estimates of contaminant concentrations. PCP field-screening results, while usable to determine the general extent of contamination, did not meet the overall criteria for use in quantitative risk assessment and were not used in the SRE. This could lead to an underestimate or overestimate of contaminant concentrations, depending on the actual contamination present at the site.

Another aspect is the use of analytical quantitation limits that could allow potentially hazardous concentrations of some chemicals to go undetected. Of greatest concern with respect to inadequate detection limits are contaminants for which a large number of nondetect results were reported, and whose detection limits approach or exceed levels potentially associated with significant health risks. Generally, the detection limits used were adequate,

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with the exception of those for 1,1,2,2-tetrachloroethane and 1,1-dichloroethene in groundwater samples. The SQLs for these chemicals (which were not detected) correspond to risks above EPA's generally acceptable risk range. This source of uncertainty reduces the level of confidence that can be placed in the upper limit of the risk associated with environmental media in which these contaminants could be present at or close to the detection limit.

Exposure Point Concentration Estimates

Whenever possible, exposure point concentrations were estimated directly from measured concentrations in the exposure medium. However, because air data were not collected, exposure point concentrations for vapors and particulate contaminants in ambient air were estimated from concentrations measured in soil. Modeling input values were based on site-specific or regional information, when available, or recommended default values. Because of uncertainties in the modeling, conservative (health-protective) assumptions were made that probably led to overestimation of air concentrations, especially vapor concentrations, on the site. In addition, air concentrations of COPCs are expected to undergo some dilution with increasing distance from the source. This dilution would reduce the estimated risks to off-site residents via the inhalation pathway.

Exposure Estimation Calculations

The primary uncertainty regarding the exposure estimation calculations is associated with the selection of appropriate parameter values. The values used and a brief rationale for their selection are provided in Section 3.1.2.2, which describes the exposure calculations for the various pathways evaluated. Because there is no information on actual current exposures, and because future exposures are unknown, the exposure values selected are either EPA-recommended default values or estimates based on professional judgment. Individual parameter values for RME cases were selected so that the overall pathway exposure estimates would approximate reasonable maximum exposures that are conservative, but still within the range of possible exposures.

Steady-State Assumption

Most of the exposure calculations used in this risk assessment assume that the concentrations of COPCs in the source media are at steady state and will remain constant for the duration of the potential exposure periods, which range from 6 to 30 years. Actual COPC concentrations could increase, remain the same, or possibly decrease over these time periods depending on both site-specific and chemical-specific factors.

The site is currently inactive and a number of the sources of current site contamination are now gone. The steady-state assumption

3. Streamlined Risk Evaluation

appears to be appropriate for inorganic COPCs in soil. Since these chemicals are relatively immobile and do not degrade, their concentrations in soil will probably change very little over the exposure periods of interest. Although some organic compounds, notably dioxins and pesticides, are also relatively immobile and persistent, they can migrate slowly from soils, and, under favorable conditions, they can degrade as a result of chemical or biological transformations. This suggests that concentrations in soil might actually decrease over longer exposure periods. Volatile and semivolatile organic chemicals can evaporate from surface and near-surface soils or migrate, thereby reducing their concentrations in soil substantially over time. Although volatilization of some chemicals was recognized and estimated to calculate air exposures in the risk assessment, there was no corresponding correction for the decrease in soil concentrations. As a result, the concentrations of these chemicals in soil over longer exposure periods were probably overestimated. Contaminant levels in groundwater could increase (as chemicals leach from soils) or decrease (by dilution, dispersion, or degradation) depending on many site-specific factors.

Because information needed to reliably estimate future concentrations of COPCs is not readily available, the steady-state assumption was used.

Summary of Exposure Assessment Uncertainties

Overall, the exposure estimates obtained are moderately reliable for COPCs at the JW site. Several of the factors adding uncertainty to the estimates tend to result in overestimation of exposure. These include:

- The directed nature of some elements of the sampling program (i.e., dioxins/furans, subsurface soils, and groundwater);
- The use of conservatively estimated or extrapolated values for some exposure point concentrations;
- The use of the steady-state assumption for estimating soil exposure point concentrations; and
- The use of conservative exposure parameter values in the exposure estimation calculations.

One factor that could lead to underestimation of the exposures is:

- The use of sample quantitation limits that could result in missing low concentrations of some contaminants that might pose significant risks. However, only two chemicals were excluded from the HHRE that meet this criterion.

3. Streamlined Risk Evaluation

Finally, one factor that could lead to overestimation or underestimation of exposures is:

- The use of the steady-state assumption for groundwater exposure concentration estimates.

The cumulative effect of all of the exposure uncertainties most likely is to overestimate the true potential exposure of receptors at the site.

3.1.5.2 Uncertainties Related to the Toxicity Assessment

Because of the number of assumptions, data points, and calculations used to derive toxicity indices, a degree of uncertainty is necessarily associated with the numerical toxicity values in any risk assessment. To evaluate the meaning of any risk assessment, the uncertainties in the assumptions made, the potential impact of quantitative changes in those assumptions on the risk estimates, and the relevance of the findings to real-world exposures and risks must be considered.

Evaluation of Noncancer Toxicity Assessment Assumptions

Key assumptions used in assessing the likelihood of noncarcinogenic effects are that threshold doses exist, below which various noncarcinogenic effects do not occur and that the occurrence or absence of noncarcinogenic effects can be extrapolated between species and occasionally between routes of exposure and over varying exposure durations. The threshold assumption appears to be sound for most noncarcinogens based on reasonably good fits of experimental data to the usual dose response curves. One possible exception to this is lead, which may not have a threshold base for its noncarcinogenic effects (ATSDR 1991).

The other general assumptions appear to be true to varying degrees. The effects observed in one species or by one route of exposure may not occur in another species or by another route, or they may occur at a higher or lower dose because of differences in the bio-kinetics of a compound in different species, or when exposure occurs by different routes. The uncertainty in these assumptions is taken into account in the development of RfDs through the use of safety or uncertainty factors. These factors reflect uncertainty associated with species-to-species extrapolation, and include safety factors to protect sensitive individuals. The uncertainty factors associated with the RfDs used in this risk assessment range from as low as 3 for the oral RfDs for arsenic or manganese, which are derived from human chronic exposure studies, to as high as 3,000 for the oral RfD of 2,4-dimethylphenol,

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which is derived from a subchronic mouse study.

The uncertainty factors used by EPA are conservative (health-protective) in nature in that they tend to overestimate the uncertainties so that the RfDs obtained are unlikely to be too high. Use of the resulting RfDs tends to overestimate the potential for noncarcinogenic effects occurring at a given exposure level.

Evaluation of Toxicity Assessment Assumptions for Chemical Carcinogens

The COPCs have been evaluated by EPA using its weight-of-evidence carcinogenicity evaluation criteria and have been placed in Group A, human carcinogens, or Group B, probable human carcinogens, based on sufficient data in humans or sufficient data in animals and insufficient data in humans, respectively (EPA 1986).

Rodent bioassay and epidemiological studies would require tens of thousands of animals or humans to determine whether a chemical may be carcinogenic at low doses. As the relationship between tumor location, time to appearance, and the proportion of animals with cancer determines the estimated carcinogenic SF, animal bioassay or human epidemiological data are not routinely sufficient for directly estimating SFs at low doses. Therefore, by necessity, agencies such as EPA use carcinogenic extrapolation models to estimate low-dose SFs from the results of higher-level exposures. Based upon prudent public policy, the agencies also assume that there is no threshold dose below which carcinogenic risks will not occur. This is equivalent to the assumption that every dose above zero, no matter how low, carries with it a small but finite risk of cancer. They also assume that the dose-response relationship is linear at low doses. This is contrary to approaches used for other toxic effects, for which thresholds are assumed to exist.

The current extrapolation model favored by EPA and certain other federal regulatory agencies is the linearized multistage model. EPA then uses the statistically derived upper 95th percent confidence bounds, rather than a maximum likelihood value, for the SF. EPA has concluded, based on theoretical grounds consistent with human epidemiological and animal data, that cancer follows a series of discrete stages (i.e., initiation, promotion, and progression) that ultimately can result in the uncontrolled cell proliferation known as cancer. Consistent with this conclusion, the use of the linearized multistage model permits an estimation of SF that is not likely to be exceeded if the real slope could be measured. However, compelling scientific arguments can be made for several other extrapolative models that, if used, could result in significantly lower SFs than those estimated using the linearized multistage model. The one-hit model, used to

3. Streamlined Risk Evaluation

estimate risks due to exposures above the linear range of the multi-stage model, is one such model. Thus, the current EPA SFs calculated in this fashion represent upper-bound values that should not be interpreted as necessarily equivalent to actual human cancer potencies. It is these conservative values, nevertheless, that are used in this risk assessment on policy grounds for the protection of public health.

Uncertainties Associated with Route-to-Route Extrapolation

Route-to-route extrapolation of RfDs and SFs adds another source of uncertainty to the risk estimates obtained through their use. Such extrapolation may result in either under- or overestimation of the true risks for the extrapolated route. This uncertainty is of particular concern when extrapolating between the oral and inhalation routes, because the biokinetics and toxicity associated with inhalation exposure may differ considerably from those associated with ingestion. This is particularly true for some metals. In this assessment, extrapolation of toxicity factors from the oral route to the inhalation route was not done for metals, but was done for some organic contaminants.

Because EPA has not developed dermal toxicity values for most chemicals, oral toxicity values are commonly used to evaluate exposures by the dermal route. The oral toxicity values must be adjusted from an administered dose basis to an absorbed dose basis using oral absorption factors, which in most cases have been estimated from very limited data. This is an additional source of uncertainty because oral absorption can vary widely depending on the chemical form, conditions of exposure, and the animal species being exposed. Although route-to-route extrapolation adds uncertainty to the risk assessment process, it appears to be preferable to omitting these exposures from the quantitative risk assessment, which would increase the possibility of underestimation of the overall risks.

Summary of Toxicity Assessment Uncertainties

The basic uncertainties underlying the assessment of the toxicity of a chemical include:

- Uncertainties arising from the design, execution, or relevance of the scientific studies that form the basis of the assessment; and
- Uncertainties involved in extrapolating from the underlying scientific studies to the exposure situation being evaluated, including variable responses to chemical exposures within human and animal populations, between species, and between routes of exposure.

3. Streamlined Risk Evaluation

These basic uncertainties could result in a toxicity estimate, based directly on the underlying studies, that either under- or over-estimates the true toxicity of a chemical.

The toxicity assessment process compensates for these basic uncertainties through the use of safety factors (uncertainty factors) and modifying factors when assessing noncarcinogens and the use of the upper 95th percent confidence limit from the linearized multistage model for the SF when assessing carcinogens. The use of the safety factors and the upper 95th percent confidence limit in deriving the RfDs and SFs ensures that the toxicity values used in the risk estimation process are unlikely to underestimate the true toxicity of a chemical.

In addition to these basic uncertainties, additional uncertainty is introduced by the route-to-route extrapolation of toxicity values. However, this practice reduces the chance that overall risks from site contamination will be underestimated.

3.1.5.3 Uncertainty in the Lead Exposure Assessment

Uncertainties in the lead assessment are related to the lack of site-specific data (i.e., baseline blood lead and individual geometric standard deviation on which to estimate exposure and biokinetic uptake of lead for workers at the site. In lieu of site-specific data, values were selected to be protective of the most sensitive potential population.

Other sensitive factors in the lead evaluation include the fraction of lead absorbed in the gut and the ratio of lead in dust to that in soil. The actual fraction of lead absorbed following ingestion may be affected by a number of factors, including degree of fasting and the particular lead salt that is ingested. Pregnant women also may experience increased absorption of lead. The assumption that lead concentrations in soil and dust were absorbed equally following ingestion is a conservative estimate, given that factors such as bioavailability of lead in the soil medium, and particle size of the ingested material may all affect the lead absorption rate in the gastrointestinal tract. In addition, the actual ratio of exposure to dust vs. soil for the receptors and the fraction of lead in dust and soil at the site is not known. Additional uncertainty exists regarding other potential exposure scenarios and pathways of lead exposure. Future scenarios at the site could occur (such as construction excavation), in which workers may be exposed to greater amounts of lead-contaminated soil for shorter durations (e.g., 6 to 12 months).

3.1.5.4 Other Uncertainties

Two additional factors need to be considered when discussing

3. Streamlined Risk Evaluation

uncertainties associated with the overall risk characterization: the cumulative effect of using conservative assumptions throughout the process, and the likelihood of the exposures postulated and estimated in the exposure assessment actually occurring.

The cumulative effect of using conservative assumptions throughout the risk estimation process could be to substantially overestimate the true risks. However, exposure factors used in this assessment were based on site-specific information, whenever it was available. Consequently, the risk estimates obtained for the JW site are believed to be sufficiently conservative to adequately protect human health, while generally remaining within the range of risks that individuals in the area may actually experience.

The last uncertainty factor to consider is the likelihood of the postulated exposures actually occurring at the JW site. The soil exposure pathways identified as complete under current conditions are all plausible, and exposure is either presently occurring by these pathways or such exposure could reasonably be expected. Although the postulated frequencies of occurrence may overestimate average occurrence, they could reflect the actual exposures of some individuals.

Conversion of the site to industrial or commercial use and exposure of site workers and nearby residents to site soils by the same routes in the future is also plausible. Exposure to contaminants through the use of site groundwater as a drinking water source is considered unlikely because there is a public water system that serves the area.

SERE
Streamlined Ecological
Risk Evaluation

IDNR
Illinois Department of
Natural Resources

3.2 Streamlined Ecological Risk Evaluation

The objective of the Streamlined Ecological Risk Evaluation (SERE) is to provide preliminary information on the potential ecological risks resulting from contamination at the JW site. Specifically, this evaluation describes the ecology of the site and its vicinity, reviews potential ecological receptors and contaminant exposure pathways, and evaluates the potential ecological risks posed by on-site contamination. This SERE was prepared in accordance with applicable regional and national ecological risk assessment guidance (EPA 1997e, 1996c, 1996d).

The SERE was prepared based on information collected by E & E during the site characterization investigation from July through September 1997. Federal and state agencies were contacted for information on sensitive habitats and protected species in the vicinity of the site, and relevant maps were reviewed to identify nearby sensitive habitats. In addition, information was obtained from a local Illinois Department of Natural Resources (IDNR) representative who visited the site. Correspondence obtained



3. Streamlined Risk Evaluation

during the preparation of this SERE are included in Appendix I.

3.2.1 Site Description

The JW site is located in a primarily industrial and residential area on the northwest side of Granite City, approximately 6 miles to the northeast of St. Louis, Missouri. The site is a 16.6-acre triangular parcel situated approximately 2 miles east of the Mississippi River; and bordered to the east by railroad tracks, to the north by 23rd Street and an Illinois-American Water Company water works facility, and to the west by an alley and a residential neighborhood.

Between 1900 and 1989, the JW facility treated railroad ties and wood block flooring using creosote, PCP, and zinc naphthenate. In addition, Jennite (a driveway sealer), was produced on site. Site activities resulted in surface and subsurface soil and groundwater contamination consisting of VOCs, SVOCs, metals, and pesticides.

On-site structures include five abandoned buildings, two silos, and various debris piles, pits, and sumps (see Figure 1-2). Shallow groundwater flow is generally to the south-southwest towards the Mississippi River. Approximately one half of the site is vegetated with grasses, weeds, shrubs, and a few trees. There are several unvegetated gravel areas where former buildings and/or ASTs were located, treatment or manufacturing processes were conducted, or waste was stockpiled (E & E 1997).

3.2.2 Terrestrial Habitat

The terrestrial habitat at the JW site is of low value to wildlife due to the primarily industrial and residential setting and the overall low quality of ecological resources. Plant species identified at the site, as shown in Table 3-20, consist predominantly of resistant herbaceous species including the balsam ragwort (*Senecio pauperculus*), the hairy goldenrod (*Solidago hispida*), the long-leaved sparrow (*Veronica longifolia*), and the partridge pea (*Cassia fasciculata*). Trees and shrubs identified at the site include common catalpa (*Catalpa tomentosa*), pumpkin ash (*Fraxinus tomentosa*), and white ash (*Fraxinus americana*).

Although the terrestrial habitat at the site can provide a food source for songbirds and small mammals, plant species diversity is low (primarily grasses and weeds) and precludes an abundance of wildlife species. In addition, the proximity to anthropogenic activity (residential areas, the railroad, and the water works) discourages wildlife species from using the site. Consequently, only common wildlife species accustomed to human activity and disturbance such as the house sparrow (*Passer domesticus*), the raccoon (*Procyon lotor*), the short-tailed shrew (*Blarina brevicauda*), and the opossum (*Didelphis sp.*), are likely to use the site. See Table 3-21.

3. Streamlined Risk Evaluation

3.2.3 Aquatic Habitat

There are no surface water bodies within the boundaries of the JW site. The closest water body is an unnamed intermittent stream that flows parallel to the Chain of Rocks Canal and is located approximately 1 mile to the northwest of the site. Although there are no fish sampling data for this stream, it is expected to support a low diversity of stress-tolerant species (see Table 3-22) (Sauer 1997).

NWI
National Wetland
Inventory

The closest wetland, an approximately 1-acre emergent wetland, is located one-half mile to the northwest of the site. Several additional and larger National Wetland Inventory (NWI) wetlands are located beyond the 0.75-mile radius from the site. These areas are considered important heron nesting areas (rookeries) and are approximately 1 mile north and northwest of the site. As shown in Table 3-21, avian species including black-crowned night herons (*Nyctanassa nyctocorax*), cattle egrets (*Bubulcus ibis*), great egrets (*Cassmerosius albus*), great blue herons (*Ciconiiformes ardeidae*), little blue herons (*Florida caerulea*), pipe-billed grebes (*Podilymbus podiceps*), sand pipers (*Scolapacidae sp.*), snowy egrets (*Egretta thula*), and yellow crowned night herons (*Nyctanassa violacea*) are likely to use the wetland areas (Tecic 1997). These species are not expected to use the JW site, however, due to the lack of adequate habitat.

Figure 3-4 depicts wetland and stream locations in relation to the JW site. Due to the distance of the aquatic resources from the site and the lack of defined surface drainage and contaminant migration pathways, site contaminants are not likely to impact aquatic resources in the vicinity of the site.

3.2.4 Rare, Threatened, and Protected Species

IDNR was contacted for information on state and federally listed species and sensitive habitats in the vicinity of the JW site. According to the Natural Heritage Database, there are no known occurrences of rare, threatened, and/or protected species within a 1-mile radius of the site or within 15 miles downstream of it (Hostetler 1997). However, during the week of August 29, E & E identified a heron with a fractured wing that was unable to fly in the concrete basin. The heron was subsequently identified as a little blue heron (*Florida caerulea*), an endangered species, by a local IDNR representative and transferred to a Wildlife Rehabilitation Center (Tecic 1997). The presence of the little blue heron does not indicate regular site use by this species but instead, a chance occurrence with little relevance to actual site conditions.

3. Streamlined Risk Evaluation

3.2.5 Exposure Pathways and Conceptual Site Model

Contaminated media at the site include surface and subsurface soils, and groundwater. Potential contaminant migration pathways include leaching and infiltration of chemicals from the surface and subsurface soils to groundwater and surface runoff. Since there is no aquatic habitat at the site, only terrestrial wildlife species could potentially be exposed to contaminants in surface soil through incidental ingestion of soil and ingestion of contaminated prey or vegetation. However, as discussed above, the terrestrial habitat of the site is of very low value to wildlife and ecological receptors are restricted to occasional common species. In addition, since the JW property is of low value to wildlife, even these common species are likely to depend on more suitable off-site areas for a significant proportion of their total diet. Consequently, wildlife exposure to site contamination is expected to be insignificant.

3.2.6 Streamlined Ecological Risk Evaluation Conclusions

A quantitative ecological risk evaluation for the JW site was not performed because the findings of the SERE indicate that the site is not likely to impact wildlife. Specifically, the following findings were made for the JW SERE:

- Only approximately 50% of the site is vegetated, plant species at the site are of low value to wildlife, and there are no aquatic resources at the site. Habitat at the JW site is of a very low quality to wildlife;
- The site is located in an industrial and residential area. Only common wildlife accustomed to human activity and disturbance could potentially use the site, and would likely do so only as transient or "visiting" species;
- The closest aquatic resource is an unnamed intermittent stream approximately 1 mile from the site. This stream is likely populated by a low diversity of stress-tolerant species. Site contaminants are not likely to impact this stream because of the distance from the site and the absence of contaminant migration routes;
- The closest ecologically sensitive areas are wetland pockets and heron rookeries located approximately 1 mile to the north and northwest of the site. Site contaminants are not likely to impact this resource; and
- Site remediation is planned. Consequently, off-site contaminant migration (groundwater and surface soil) will be mitigated, and the already-low potential for exposure from surface soil will be further decreased.

3. Streamlined Risk Evaluation

Based on the above, no adverse impacts to wildlife and/or sensitive habitats in the vicinity of the site are expected to result from contamination at the JW site. Based on currently available site information, a quantitative ecological risk assessment is not recommended.

<p align="center">Table 3-1</p> <p align="center">CHEMICALS OF POTENTIAL CONCERN IN SOIL AND GROUNDWATER</p> <p align="center">STREAMLINED HUMAN HEALTH RISK EVALUATION</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>			
Chemical	Medium		
	Surface Soil	Subsurface Soil	Groundwater
Acenaphthene	X	X	X
Arsenic			X
Benzene		X	X
Benzo(a)anthracene	X		
Benzo(a)pyrene	X	X	
Benzo(b)fluoranthene	X	X	X
Benzo(k)fluoranthene	X	X	X
Beryllium	X		
Carbazole	X	X	
Chloroform			X
Chromium	X		
Chrysene	X	X	X
Di(2-ethylhexyl)phthalate			X
Dibenzo(a,h)anthracene	X	X	
1,2-Dichloroethane			X
2,4-Dimethylphenol		X	X
Ethylbenzene			X
alpha-Hexachlorocyclohexane	X		X
Indeno(1,2,3-cd)pyrene	X	X	
Lead	X		X
Manganese	X		X
Methylene chloride			X
2-Methylphenol			X
Naphthalene	X	X	X
Pentachlorophenol	X	X	X

Table 3-1 CHEMICALS OF POTENTIAL CONCERN IN SOIL AND GROUNDWATER STREAMLINED HUMAN HEALTH RISK EVALUATION JENNISON-WRIGHT SITE GRANITE CITY, ILLINOIS			
Chemical	Medium		
	Surface Soil	Subsurface Soil	Groundwater
Phenol			X
2,3,7,8 TCDD Equivalents ^a	X		
Thallium			X
Toluene			X
Trichloroethene			X

^a Based on a Toxicity Equivalency Factor approach for 2,3,7,8 TCDD and other dioxins/furans.

Table 3-2

**EXPOSURE PATHWAYS EVALUATED FOR THE JENNISON-WRIGHT
STREAMLINED RISK EVALUATION**

Scenario Time Frame	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection
Current	Soil	Soil	Surface Soil	Site Visitor	Adolescent	Ingestion Dermal	On-Site On-Site	Quant.	Evidence of trespassing has been observed at the site.
		Air	Vapors and Particulate Matter	Nearby Residents	Adult	Inhalation	Off-Site	Quant.	Residents currently live adjacent to the site; odors were noted in areas of the site, and exposed soil (which may contribute to airborne dust) is present in portions of the site.
					Child	Inhalation	Off-Site	Quant.	
				Site Visitor	Adolescent	Inhalation	On-Site	Quant.	Evidence of trespassing has been observed at the site.
		Future	Soil	Soil	Surface Soil	Permanent Site Worker	Adult	Ingestion Dermal	On-Site
Surface and Subsurface Soil	Construction Worker				Adult	Ingestion Dermal	On-Site	Quant.	Potential redevelopment may involve construction excavation in contaminated areas of the site.
Air	Vapors and Particulate Matter			Permanent Site Worker	Adult	Inhalation	On-Site	Quant.	Odors were noted in areas of soil contamination. Areas of the site contain exposed soil.
				Construction Worker	Adult	Inhalation	On-Site	Quant.	Odors were noted in areas of soil contamination. Construction excavation will bring contaminated soil to the surface and remove vegetative cover.
				Nearby Residents	Adult	Inhalation	Off-Site	Quant.	Residential areas adjacent to the site could be exposed to vapors and particulate matter from contaminated soil.
					Child	Inhalation	Off-Site	Quant.	

Table 3-2

**EXPOSURE PATHWAYS EVALUATED FOR THE JENNISON-WRIGHT
STREAMLINED RISK EVALUATION**

Scenario Time Frame	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection
Future (Cont.)	Groundwater	Ground- water	22nd Street Lagoon - Well Water	Permanent Site Worker	Adult	Ingestion	On-Site	Quant.	A drinking water well could potentially be placed on the site during redevelopment.
			Area H - Well Water						
			Jennite Pit Area - Well Water						
			PCP Process Area - Well Water						

Key:

Quant. = Quantitative.

Table 3-3

**EXPOSURE POINT CONCENTRATIONS FOR CHEMICALS OF POTENTIAL CONCERN
JENNISON-WRIGHT SITE, GRANITE CITY, ILLINOIS**

Exposure Point Concentration Set	Location	Chemical	Units	Number of Samples	Number of Detects	Expo. Point Conc.	Expo. Point Conc. Source
Surface Soil	Onsite	Acenaphthene	mg/kg	92	44	4.86E+02	UCL - Lognormal
		alpha-BHC	mg/kg	27	5	9.24E-03	UCL - Lognormal
		Benzo[a]anthracene	mg/kg	92	81	3.62E+02	UCL - Lognormal
		Benzo[a]pyrene	mg/kg	92	89	1.48E+02	UCL - Lognormal
		Benzo[b]fluoranthene	mg/kg	92	89	1.70E+02	UCL - Lognormal
		Benzo[k]fluoranthene	mg/kg	92	87	1.61E+02	UCL - Lognormal
		Beryllium	mg/kg	27	26	2.71E+00	UCL - Lognormal
		Carbazole	mg/kg	27	24	4.47E+03	UCL - Lognormal
		Chromium (III)	mg/kg	27	27	2.07E+02	UCL - Lognormal
		Chromium (VI)	mg/kg	27	27	4.14E+01	UCL - Lognormal
		Chrysene	mg/kg	92	87	4.09E+02	UCL - Lognormal
		Dibenz[a,h]anthracene	mg/kg	92	63	2.72E+01	UCL - Lognormal
		Indeno[1,2,3-cd]pyrene	mg/kg	92	86	6.05E+01	UCL - Lognormal
		Manganese	mg/kg	27	27	6.63E+03	UCL - Lognormal
		Naphthalene	mg/kg	92	23	1.21E+02	UCL - Lognormal
		Pentachlorophenol	mg/kg	26	7	2.76E+02	UCL - Lognormal
		TCDD-TEF	mg/kg	11	11	6.64E-02	Max Detected
Soil <10 ft	Onsite	Acenaphthene	mg/kg	130	53	3.58E+02	UCL - lognormal
		alpha-BHC	mg/kg	40	5	5.23E-03	UCL - lognormal
		Benzene	mg/kg	14	3	4.20E+00	Max Detected
		Benzo[a]anthracene	mg/kg	130	93	2.61E+02	UCL - lognormal
		Benzo[a]pyrene	mg/kg	130	100	1.08E+02	UCL - lognormal
		Benzo[b]fluoranthene	mg/kg	130	102	1.24E+02	UCL - lognormal
		Benzo[k]fluoranthene	mg/kg	130	97	1.15E+02	UCL - lognormal
		Beryllium	mg/kg	40	35	1.97E+00	UCL - lognormal
		Carbazole	mg/kg	48	26	3.53E+02	UCL - lognormal
		Chromium (III)	mg/kg	40	40	1.14E+02	UCL - lognormal
		Chromium (VI)	mg/kg	40	40	2.28E+01	UCL - lognormal
		Chrysene	mg/kg	130	100	2.94E+02	UCL - lognormal
		Dibenz[a,h]anthracene	mg/kg	130	69	1.99E+01	UCL - lognormal
		Indeno[1,2,3-cd]pyrene	mg/kg	130	98	4.41E+01	UCL - lognormal
		Manganese	mg/kg	40	40	4.78E+03	UCL - lognormal
		Naphthalene	mg/kg	130	37	1.36E+02	UCL - lognormal
		Pentachlorophenol	mg/kg	47	12	1.07E+02	UCL - lognormal
		TCDD-TEF	mg/kg	11	11	6.64E-02	Max Detected
Groundwater	22nd St. Lagoon	2,4-Dimethylphenol	mg/L	4	1	1.50E+01	Max Detected
		2-Methylphenol	mg/L	4	2	2.10E+01	Max Detected
		Acenaphthene	mg/L	5	4	4.60E-01	Max Detected

Source: Ecology and Environment, Inc. 1999

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Table 3-3

**EXPOSURE POINT CONCENTRATIONS FOR CHEMICALS OF POTENTIAL CONCERN
JENNISON-WRIGHT SITE, GRANITE CITY, ILLINOIS**

Exposure Point Concentration Set	Location	Chemical	Units	Number of Samples	Number of Detects	Expo. Point Conc.	Expo. Point Conc. Source
Groundwater	22nd St. Lagoon	Arsenic	mg/L	3	2	2.46E-02	Max Detected
		Benzene	mg/L	3	2	6.60E+00	Max Detected
		Benzo[a]anthracene	mg/L	5	2	1.90E-01	Max Detected
		Benzo[b]fluoranthene	mg/L	5	3	1.80E-01	Max Detected
		Benzo[k]fluoranthene	mg/L	5	2	1.20E-01	Max Detected
		Chloroform	mg/L	2	1	8.00E-03	Max Detected
		Chrysene	mg/L	5	2	1.90E-01	Max Detected
		Ethylbenzene	mg/L	3	3	8.00E-01	Max Detected
		Lead	mg/L	3	2	5.50E-03	Max Detected
		Manganese	mg/L	3	3	5.81E+00	Max Detected
		Methylene Chloride	mg/L	3	3	2.40E-02	Max Detected
		Naphthalene	mg/L	5	5	2.10E+01	Max Detected
		Pentachlorophenol	mg/L	4	3	1.40E+00	Max Detected
		Phenol	mg/L	4	2	6.00E+00	Max Detected
		Thallium	mg/L	3	1	4.40E-03	Max Detected
		Toluene	mg/L	3	2	3.40E+00	Max Detected
Groundwater	Area H	2,4-Dimethylphenol	mg/L	1	1	1.00E-03	Single Value
		bis(2-Ethylhexyl)phthalate	mg/L	1	1	2.00E-03	Single Value
		Lead	mg/L	1	1	4.40E-03	Single Value
		Manganese	mg/L	1	1	9.94E-01	Single Value
		Methylene Chloride	mg/L	1	1	3.00E-03	Single Value
		Naphthalene	mg/L	1	1	1.20E-02	Single Value
		Pentachlorophenol	mg/L	1	1	4.80E-02	Single Value
Groundwater	Jennite Pit	1,2-Dichloroethane	mg/L	1	1	3.00E-03	Single Value
		Acenaphthene	mg/L	3	2	1.00E-02	Max Detected
		Arsenic	mg/L	3	1	3.20E-03	Max Detected
		Lead	mg/L	3	3	5.12E-02	Max Detected
		Manganese	mg/L	3	3	8.88E-01	Max Detected
		Methylene Chloride	mg/L	3	3	8.00E-03	Max Detected
Groundwater	PCP Process Area	Acenaphthene	mg/L	2	1	1.10E-01	Max Detected
		alpha-BHC	mg/L	2	1	2.60E-04	Max Detected
		Arsenic	mg/L	2	1	6.40E-02	Max Detected
		Benzene	mg/L	2	1	9.00E-03	Max Detected
		Ethylbenzene	mg/L	2	1	1.70E-02	Max Detected
		Lead	mg/L	2	2	5.59E-02	Max Detected
		Manganese	mg/L	2	2	4.89E+00	Max Detected
		Methylene Chloride	mg/L	2	2	3.00E-03	Max Detected
		Pentachlorophenol	mg/L	2	1	8.80E+01	Max Detected

Source: Ecology and Environment, Inc. 1999

Key at end of table

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Table 3-3

Key:

Max. detected	= Maximum detected value.
mg/kg	= Milligrams per kilogram or parts per million.
mg/L	= milligrams per liter or parts per million.
UCL - normal	= 95% upper confidence limit of the arithmetic average for normally distributed data.
UCL - lognormal	= 95% upper confidence limit of the arithmetic average for lognormally distributed data.

Source: Ecology and Environment, Inc., 1999.

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Table 3-4

**SCENARIO 1: CURRENT SITE VISITOR
PATHWAY 1A: INCIDENTAL INGESTION OF ON-SITE SOIL
STREAMLINED HUMAN HEALTH RISK EVALUATION
JENNISON-WRIGHT SITE**

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CS \times IR \times CF \times FI \times ED \times EF}{BW \times AT}$$

where:

CS = Chemical concentration in soil (mg/kg)
 CF = Conversion factor (10^{-6} kg/mg)
 IR = Ingestion Rate (mg soil/day)
 FI = Fraction ingested from contaminated source (unitless)
 EF = Exposure frequency (events/year)
 ED = Exposure duration (years)
 BW = Body weight (kg)
 AT = Averaging time (days)

Variable	Receptor	Case	Value (Rationale/Source)
CS	Adolescent	RME	Lower of UCL or maximum detected concentration in soil.
IR	Adolescent	RME	100 mg/day (age groups greater than 6 years old; EPA 1991)
FI	Adolescent	RME	1.0 (assumes all of ingested soil is from the site).
EF	Adolescent	RME	43 days/year (derived from EPA 1997b; see text)
ED	Adolescent	RME	8 years (entire duration of age group; see text)
BW	Adolescent	RME	42 kg (average body weight for age group; EPA 1989)
AT	Adolescent	RME	Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED × 365 days/year) and 70-year lifetime for carcinogenic effects (i.e., 70 years × 365 days/year) (EPA 1989)

Key:

EPA = United States Environmental Protection Agency.
 mg/kg = Milligrams per kilogram.
 RME = Reasonable maximum exposure.
 UCL = Upper confidence limit.

Table 3-5

**SCENARIO 1: CURRENT SITE VISITOR
PATHWAY 1B: DERMAL CONTACT WITH SOIL
STREAMLINED HUMAN HEALTH RISK EVALUATION
JENNISON-WRIGHT SITE**

Equation:

$$Intake (mg/kg-day) = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

where:

CS = Chemical concentration in soil (mg/kg)
 CF = Conversion factor (10^{-6} kg/mg)
 SA = Skin surface area available for contact (cm²/event)
 AF = Soil to skin adherence factor (mg/cm²)
 ABS = Absorption factor (unitless)
 EF = Exposure frequency (events/year)
 ED = Exposure duration (years)
 BW = Body weight (kg)
 AT = Averaging time (days)

Variable	Receptor	Case	Value (Rationale/Source)
CS	Adolescent	RME	Lower of UCL or maximum detected concentration in soil.
SA	Adolescent	RME	2,458 cm ² /event (derived from EPA 1997a; see text)
AF	Adolescent	RME	1.0 mg/cm ² (EPA 1992c)
ABS	Adolescent	RME	Chemical-specific value (see Appendix I, Table I-4; (EPA 1992c)
EF	Adolescent	RME	43 days/year (derived from EPA 1997b; see text)
ED	Adolescent	RME	8 years (entire duration of age group; see text)
BW	Adolescent	RME	42 kg (average body weight for age group; EPA 1989)
AT	Adolescent	RME	Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED × 365 days/year) and 70-year lifetime for carcinogenic effects (i.e., 70 years × 365 days/year) (EPA 1989)

Key:

EPA = United States Environmental Protection Agency.
 mg/kg = Milligrams per kilogram.
 RME = Reasonable maximum exposure.
 cm² = Square centimeter.
 UCL = Upper confidence limit.

Table 3-6

**SCENARIO 1: CURRENT SITE VISITOR
PATHWAY 1C: INHALATION OF VAPORS AND PARTICULATES FROM SOIL
STREAMLINED HUMAN HEALTH RISK EVALUATION
JENNISON-WRIGHT SITE**

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CS \times ED \times EF \times IR_{\text{air}} \times (1/VF \text{ or } 1/PEF)}{BW \times AT}$$

where:

CS = Chemical concentration in soil (mg/kg)

CF = Conversion factor (10^{-6} kg/mg)

EF = Exposure frequency (events/year)

ED = Exposure duration (years)

 IR_{air} =Inhalation rate (m^3/day)VF = Volatization Factor (mg^3/kg)

PEF =

Particulate Emission Factor (mg^3/kg)

BW = Body weight (kg)

AT = Averaging time (days)

Variable	Receptor	Case	Value (Rationale/Source)
CS	Adolescent	RME	Lower of UCL or maximum detected concentration in soil.
IR_{air}	Adolescent	RME	$1.5 \text{ m}^3/\text{day}$ (rate of $1.0 \text{ m}^3/\text{hr}$ for 1.5 hours per day; EPA 1997a)
VF	Adolescent	RME	Chemical-specific (see Appendix I, Tables I6-I8).
PEF	Adolescent	RME	$7.31 \times 10^8 \text{ m}^3/\text{kg}$ (calculated; see Appendix I, Table I-9)
EF	Adolescent	RME	43 days/year (derived from EPA 1997b; see text)
ED	Adolescent	RME	8 years (entire duration of age group; see text)
BW	Adolescent	RME	42 kg (average body weight for age group; EPA 1989)
AT	Adolescent	RME	Pathway-specific period of exposure for noncarcinogenic effects (i.e., $ED \times 365 \text{ days/year}$) and 70-year lifetime for carcinogenic effects (i.e., $70 \text{ years} \times 365 \text{ days/year}$) (EPA 1989)

Key:

 m^3 = Cubic meters.

EPA = United States Environmental Protection Agency.

IPCB = Illinois Pollution Control Board.

mg/kg = Milligrams per kilogram.

RME = Reasonable maximum exposure.

UCL = Upper confidence limit.

Table 3-7

**SCENARIO 2: CURRENT NEARBY RESIDENTS
PATHWAY 2: INHALATION OF VAPORS AND PARTICULATES FROM SOIL
STREAMLINED HUMAN HEALTH RISK EVALUATION
JENNISON-WRIGHT SITE**

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CS \times ED \times EF \times IR_{\text{air}} \times (1/VF \text{ or } 1/PEF)}{BW \times AT}$$

where:

CS = Chemical concentration in soil (mg/kg)

CF = Conversion factor (10^{-6} kg/mg)

EF = Exposure frequency (events/year)

ED = Exposure duration (years)

IR_{air} =

Inhalation rate (m^3/day)

VF = Volatilization Factor (mg^3/kg)

PEF =

Particulate Emission Factor (mg^3/kg)

BW = Body weight (kg)

AT = Averaging time (days)

Variable	Receptor	Case	Value (Rationale/Source)
CS	Child/Adult	RME	Lower of UCL or maximum detected concentration in soil.
IR_{air}	Child	RME	8.3 m^3/day (EPA 1996a)
	Adult		15.2 m^3/day (EPA 1996a)
VF	Child/Adult	RME	Chemical-specific (see Appendix I, Tables I-6, I-7, and I-8).
PEF	Child/Adult	RME	$7.31 \times 10^8 \text{ m}^3/\text{kg}$ (calculated; see Appendix I, Table I-9)
EF	Child/Adult	RME	350 days/year (EPA 1989)
ED	Child	RME	6 years (entire duration of age group)
	Adult		24 years (adult portion of time spent at one residence)
BW	Child	RME	15 kg (average body weight for age group; EPA 1989)
	Adult		70 kg (average adult male; EPA 1989)
AT	Child/Adult	RME	Pathway-specific period of exposure for noncarcinogenic effects (i.e., $ED \times 365 \text{ days/year}$) and 70-year lifetime for carcinogenic effects (i.e., $70 \text{ years} \times 365 \text{ days/year}$) (EPA 1989)

Key:

m^3 = Cubic meters.

EPA = United States Environmental Protection Agency.

IPCB = Illinois Pollution Control Board.

mg/kg = Milligrams per kilogram.

RME = Reasonable maximum exposure.

Table 3-8

**SCENARIO 3: FUTURE PERMANENT SITE WORKER
PATHWAY 3A: INCIDENTAL INGESTION OF ON-SITE SOIL
STREAMLINED HUMAN HEALTH RISK ASSESSMENT
JENNISON-WRIGHT SITE**

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CS \times IR \times CF \times FI \times ED \times EF}{BW \times AT}$$

where:

CS = Chemical concentration in soil (mg/kg)
 CF = Conversion factor (10^{-6} kg/mg)
 IR = Ingestion Rate (mg soil/day)
 FI = Fraction ingested from contaminated source (unitless)
 EF = Exposure frequency (events/year)
 ED = Exposure duration (years)
 BW = Body weight (kg)
 AT = Averaging time (days)

Variable	Receptor	Case	Value (Rationale/Source)
CS	Site Worker	RME	Lower of UCL or maximum detected concentration in soil.
IR	Site Worker	RME	50 mg/day (EPA 1991)
FI	Site Worker	RME	1.0 (assumes all of ingested soil is from the site).
EF	Site Worker	RME	250 days/year (EPA 1991)
ED	Site Worker	RME	25 years (95 th percentile amount of time working at a single location [EPA 1991]).
BW	Site Worker	RME	70 kg (average adult body weight; EPA 1989)
AT	Site Worker	RME	Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED × 365 days/year) and 70-year lifetime for carcinogenic effects (i.e., 70 years × 365 days/year) (EPA 1989)

Key:

EPA = United States Environmental Protection Agency.
 mg/kg = Milligrams per kilogram.
 RME = Reasonable maximum exposure.
 UCL = Upper confidence limit.

Table 3-9

**SCENARIO 3: FUTURE PERMANENT SITE WORKER
PATHWAY 3B: DERMAL CONTACT WITH SOIL
STREAMLINED HUMAN HEALTH RISK ASSESSMENT
JENNISON-WRIGHT SITE**

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

where:

CS = Chemical concentration in soil (mg/kg)
 CF = Conversion factor (10^{-6} kg/mg)
 SA = Skin surface area available for contact (cm^2/event)
 AF = Soil to skin adherence factor (mg/cm^2)
 ABS = Absorption factor (unitless)
 EF = Exposure frequency (events/year)
 ED = Exposure duration (years)
 BW = Body weight (kg)
 AT = Averaging time (days)

Variable	Receptor	Case	Value (Rationale/Source)
CS	Site Worker	RME	Lower of UCL or maximum detected concentration in soil.
SA	Site Worker	RME	5,000 (average total skin area for adult males \times 25%; EPA 1992c)
AF	Site Worker	RME	1.0 mg/cm^2 (EPA 1992c)
ABS	Site Worker	RME	Chemical-specific value (see text) (EPA 1992c)
EF	Site Worker	RME	250 days/year (EPA 1991)
ED	Site Worker	RME	25 years (95 th percentile amount of time working at a single location [EPA 1991]).
BW	Site Worker	RME	70 kg (average adult body weight; EPA 1989)
AT	Site Worker	RME	Pathway-specific period of exposure for noncarcinogenic effects (i.e., $ED \times 365$ days/year) and 70-year lifetime for carcinogenic effects (i.e., 70 years \times 365 days/year) (EPA 1989)

Key:

EPA = United States Environmental Protection Agency.
 mg/kg = Milligrams per kilogram.
 RME = Reasonable maximum exposure.
 cm^2 = Square centimeters.
 UCL = Upper confidence limit.

Table 3-10

**SCENARIO 3: FUTURE PERMANENT SITE WORKER
PATHWAY 3C: INHALATION OF VAPORS AND PARTICULATES FROM SOIL
STREAMLINED HUMAN HEALTH RISK ASSESSMENT
JENNISON-WRIGHT SITE**

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CS \times ED \times EF \times IR_{\text{air}} \times (1/VF \text{ or } 1/PEF)}{BW \times AT}$$

where:

CS = Chemical concentration in soil (mg/kg)
 CF = Conversion factor (10^{-6} kg/mg)
 EF = Exposure frequency (events/year)
 ED = Exposure duration (years)
 IR_{air} = Inhalation rate (m^3/day)
 VF = Soil-to-Air volatilization factor (mg^3/kg)
 PEF =
 Particulate Emission Factor (mg^3/kg)
 BW = Body weight (kg)
 AT = Averaging time (days)

Variable	Receptor	Case	Value (Rationale/Source)
CS	Site Worker	RME	Lower of UCL or maximum detected concentration in soil.
IR_{air}	Site Worker	RME	$10.4 \text{ m}^3/\text{day}$ (derived from EPA 1997a; see text)
VF	Site Worker	RME	Chemical-specific (see Appendix I, Tables I-6—I-8).
PEF	Site Worker	RME	$6.91 \times 10^8 \text{ mg}^3/\text{kg}$ (see Appendix I, Table I-9).
EF	Site Worker	RME	250 days/year (EPA 1991)
ED	Site Worker	RME	25 years (95 th percentile amount of time working at a single location [EPA 1991]).
BW	Site Worker	RME	70 kg (average adult body weight; EPA 1989)
AT	Site Worker	RME	Pathway-specific period of exposure for noncarcinogenic effects (i.e., $ED \times 365 \text{ days/year}$) and 70-year lifetime for carcinogenic effects (i.e., $70 \text{ years} \times 365 \text{ days/year}$) (EPA 1989)

Key:

m^3 = Cubic meters.
 EPA = United States Environmental Protection Agency.
 mg/kg = Milligrams per kilogram.
 IPCB = Illinois Pollution Control Board.
 RME = Reasonable maximum exposure.
 UCL = Upper confidence limit.

Table 3-11

**SCENARIO 4: FUTURE PERMANENT SITE WORKER
PATHWAY 4: INGESTION OF GROUNDWATER
STREAMLINED HUMAN HEALTH RISK ASSESSMENT
JENNISON-WRIGHT SITE**

Equation:

$$Intake (mg/kg-day) = \frac{C_w \times IR \times ED \times EF}{BW \times AT}$$

where:

C_w = Chemical concentration in groundwater (mg/L)

IR = Ingestion Rate (L water/day)

EF = Exposure frequency (days/year)

ED = Exposure duration (years)

BW = Body weight (kg)

AT = Averaging time (days)

Variable	Receptor	Case	Value (Rationale/Source)
C _w	Site Worker	RME	Lower of UCL or maximum detected concentration in source area wells.
IR	Site Worker	RME	1 L/day (EPA 1991)
EF	Site Worker	RME	250 days/year (EPA 1991)
ED	Site Worker	RME	25 years (95 th percentile amount of time working at a single location [EPA 1991]).
BW	Site Worker	RME	70 kg (average adult body weight; EPA 1989)
AT	Site Worker	RME	Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED × 365 days/year) and 70-year lifetime for carcinogenic effects (i.e., 70 years × 365 days/year) (EPA 1989)

Key:

EPA = United States Environmental Protection Agency.

mg/L = Milligrams per liter.

RME = Reasonable maximum exposure.

UCL = Upper confidence limit.

Table 3-12

**SCENARIO 5: FUTURE SITE CONSTRUCTION WORKER
PATHWAY 5A: INCIDENTAL INGESTION OF ON-SITE SOIL
STREAMLINED HUMAN HEALTH RISK ASSESSMENT
JENNISON-WRIGHT SITE**

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CS \times IR \times CF \times FI \times ED \times EF}{BW \times AT}$$

where:

CS = Chemical concentration in soil (mg/kg)
 CF = Conversion factor (10^{-6} kg/mg)
 IR = Ingestion Rate (mg soil/day)
 FI = Fraction ingested from contaminated source (unitless)
 EF = Exposure frequency (events/year)
 ED = Exposure duration (years)
 BW = Body weight (kg)
 AT = Averaging time (days)

Variable	Receptor	Case	Value (Rationale/Source)
CS	Construction Worker	RME	Lower of UCL or maximum detected concentration in soil.
IR	Construction Worker	RME	480 mg/day (Soil contact intensive occupations; EPA 1991)
FI	Construction Worker	RME	1.0 (assumes all of ingested soil is from the site).
EF	Construction Worker	RME	48 days/year (assumes 2 months of construction at 6 days per week)
ED	Construction Worker	RME	0.154 year (assumes one-time construction period of 2 months).
BW	Construction Worker	RME	70 kg (average adult body weight; EPA 1989)
AT	Construction Worker	RME	Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED × 365 days/year) and 70-year lifetime for carcinogenic effects (i.e., 70 years × 365 days/year) (EPA 1989)

Key:

EPA = United States Environmental Protection Agency.
 mg/kg = Milligrams per kilogram.
 RME = Reasonable maximum exposure.
 UCL = Upper confidence limit.

Table 3-13

**SCENARIO 5: FUTURE SITE CONSTRUCTION WORKER
PATHWAY 5B: DERMAL CONTACT WITH SOIL
STREAMLINED HUMAN HEALTH RISK ASSESSMENT
JENNISON-WRIGHT SITE**

Equation:

$$Intake (mg/kg-day) = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

where:

CS = Chemical concentration in soil (mg/kg)
 CF = Conversion factor (10^{-6} kg/mg)
 SA = Skin surface area available for contact (cm^2 /event)
 AF = Soil to skin adherence factor (mg/cm^2)
 ABS = Absorption factor (unitless)
 EF = Exposure frequency (events/year)
 ED = Exposure duration (years)
 BW = Body weight (kg)
 AT = Averaging time (days)

Variable	Receptor	Case	Value (Rationale/Source)
CS	Construction Worker	RME	Lower of UCL or maximum detected concentration in soil.
SA	Construction Worker	RME	5,000 (average total skin area for adult males \times 25 %; EPA 1992c)
AF	Construction Worker	RME	1.0 mg/cm^2 (EPA 1992c)
ABS	Construction Worker	RME	Chemical-specific value (see text) (EPA 1992c)
EF	Construction Worker	RME	48 days/year (assumes 2 months of construction at 6 days per week)
ED	Construction Worker	RME	0.154 year (assumes one-time construction period of 2 months).
BW	Construction Worker	RME	70 kg (average adult body weight; EPA 1989)
AT	Construction Worker	RME	Pathway-specific period of exposure for noncarcinogenic effects (i.e., $ED \times 365$ days/year) and 70-year lifetime for carcinogenic effects (i.e., $70 \text{ years} \times 365$ days/year) (EPA 1989)

Key:

cm^2 = Square centimeter.
 EPA = United States Environmental Protection Agency.
 mg/kg = Milligrams per kilogram.
 RME = Reasonable maximum exposure.
 UCL = Upper confidence limit.

Table 3-14

**SCENARIO 5: FUTURE SITE CONSTRUCTION WORKER
PATHWAY 5C: INHALATION OF VAPORS AND PARTICULATES FROM SOIL
STREAMLINED HUMAN HEALTH RISK ASSESSMENT
JENNISON-WRIGHT SITE**

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CS \times ED \times EF \times IR_{\text{air}} \times (1/VF \text{ or } 1/PEF)}{BW \times AT}$$

where:

CS = Chemical concentration in soil (mg/kg)
 CF = Conversion factor (10^{-6} kg/mg)
 EF = Exposure frequency (events/year)
 ED = Exposure duration (years)
 IR_{air} = Inhalation rate (m³/day)
 VF = Soil-to-Air volatilization factor (mg³/kg)
 PEF =
 Particulate Emission Factor (mg³/kg)
 BW = Body weight (kg)
 AT = Averaging time (days)

Variable	Receptor	Case	Value (Rationale/Source)
CS	Construction Worker	RME	Lower of UCL or maximum detected concentration in soil.
IR _{air}	Construction Worker	RME	10.4 m ³ /day (derived from EPA 1997a; see text).
VF	Construction Worker	RME	Chemical-specific (see Appendix I, Tables I-6—I-8).
PEF	Construction Worker	RME	1.24×10^8 mg ³ /kg (see Appendix I, Table I-9).
EF	Construction Worker	RME	48 days/year (assumes 2 months of construction at 6 days per week)
ED	Construction Worker	RME	0.154 year (assumes one-time construction period of 2 months).
BW	Construction Worker	RME	70 kg (average adult body weight; EPA 1989)
AT	Construction Worker	RME	Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED × 365 days/year) and 70-year lifetime for carcinogenic effects (i.e., 70 years × 365 days/year) (EPA 1989)

Key:

m³ = Cubic meters.
 EPA = United States Environmental Protection Agency.
 IPCB = Illinois Pollution Control Board.
 mg/kg = Milligrams per kilogram.
 RME = Reasonable maximum exposure.
 UCL = Upper confidence limit.

Table 3-15

**SCENARIOS 6 AND 7: FUTURE NEARBY RESIDENTS
PATHWAYS 6 AND 7: INHALATION OF VAPORS AND PARTICULATES FROM SOIL
STREAMLINED HUMAN HEALTH RISK EVALUATION
JENNISON-WRIGHT SITE**

Equation:

$$Intake (mg/kg-day) = \frac{CS \times ED \times EF \times IR_{air} \times (1/VF \text{ or } 1/PEF)}{BW \times AT}$$

where:

CS = Chemical concentration in soil (mg/kg)

CF = Conversion factor (10^{-6} kg/mg)

EF = Exposure frequency (events/year)

ED = Exposure duration (years)

IR_{air} =

Inhalation rate (m^3 /day)

VF = Volatization Factor (mg³/kg)

PEF =

Particulate Emission Factor (mg³/kg)

BW = Body weight (kg)

AT = Averaging time (days)

Variable	Receptor	Case	Value (Rationale/Source)
CS	Child/Adult	RME	Lower of UCL or maximum detected concentration in soil.
IR_{air}	Child	RME	8.3 m^3 /day (EPA 1997a)
	Adult		15.2 m^3 /day (EPA 1997a)
VF	Child/Adult	RME	Chemical-specific (see Appendix I, Tables I-6—I-8).
PEF	Child/Adult	RME	7.31×10^8 m^3 /kg (calculated; see Appendix I, Table I-9) 1.24×10^8 m^3 /kg (during construction; see Appendix I, Table I-9)
EF	Child/Adult	RME	350 days/year (EPA 1989)
ED	Child	RME	6 years (entire duration of age group), 0.154 years during construction (assumes 2 months of exposure)
	Adult		24 years (adult portion of time spent at one residence), 0.154 years during construction (assumes 2 months of exposure)
BW	Child	RME	15 kg (average body weight for age group; EPA 1989)
	Adult		70 kg (average adult male; EPA 1989)
AT	Child/Adult	RME	Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED \times 365 days/year) and 70-year lifetime for carcinogenic effects (i.e., 70 years \times 365 days/year) (EPA 1989)

Key:

m^3 = Cubic meters.

EPA = United States Environmental Protection Agency.

IPCB = Illinois Pollution Control Board.

mg/kg = Milligrams per kilogram.

RME = Reasonable maximum exposure.

<p align="center">Table 3-16</p> <p align="center">PARAMETERS USED TO ESTIMATE THE WEIGHTED AVERAGE SOIL LEAD CONCENTRATION</p> <p align="center">FOR CHILDHOOD EXPOSURE TO LEAD IN SITE SOILS</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>		
Parameter	Case	
	Site Average Exposure	Hot Spot Exposure
Lead Concentration in Yard Soil (PbS_{yard} [mg/kg])	200	200
Lead in Site Soil (PbS_{site} [mg/kg])	160.82	581
Days Outdoors - Sidewalk, Street, Neighborhood	39	39
Days Outdoors - Outside the Residence	184	184
Site Exposure Frequency (EF_{site})	0.212	0.212
Yard Exposure Frequency (EF_{yard})	0.788	0.788
90th Percentile Minutes Outdoors - Sidewalk, Street, Neighborhood	240	240
90th Percentile Minutes Outdoors - Outside the Residence	365	365
Fraction of Time Spent at Site (F_{site})	0.658	0.658
Fraction of Time Spent in Yard (F_{yard})	0.342	0.342
Lead Concentration in Soil (Time-Weighted Average [PbS_{wgtave}])	194.5	253.1
Fraction of Lead in Dust from Soil	0.7	0.7
Dust Lead Concentration (PbD [mg/kg])	148.9	160.6

Note: Childhood exposure to the site is anticipated for children from ages 5 to 7. The values shown above were used in place of the default model parameters for those ages. Model default values were used from ages 0 to 5 years. See Appendix I for a presentation of all of the model input parameters and results.

Key:

mg/kg = Milligrams per kilogram.

Source: Ecology and Environment, Inc., 1999.

Table 3-17

**SUMMARY OF ADULT LEAD MODEL INPUTS FOR FUTURE SITE WORKER
EXPOSURE TO LEAD IN SOIL
JENNISON-WRIGHT SITE**

Equations:

$$PbB_{\text{fetal}, 0.95} = R * GSD_i^{1.645} \left[\frac{(PbS_{s+d} * BKSF * IR_{s+d} * AF_s * EF_s)}{AT} + PbB_0 \right]$$

$$RBRG = \frac{([PbB_{\text{fetal}, \text{goal}} / (R * (GSD_i^{1.645}))] - PbB_0) * AT}{BKSF * [(IR_{s+d}) * AF_s * EF_s * W_s] + [K_{SD} * (IR_{s+d}) * (1 - W_s) * AF_D * EF_D]}$$

Parameter	Description	Units	Site-Wide Average	Maximum Detected Value
$PbB_{\text{fetal}, \text{goal}}$	Threshold fetal blood lead level	µg/dL	10	10
$PbS_{s,D}$	Lead concentration in soil and dust	mg/kg	160.82	581
$R_{\text{fetal/maternal}}$	Fetal/maternal PbB ratio	--	0.9	0.9
BKSF	Biokinetic slope factor	µg/dl per µg/day	0.4	0.4
GSD_i	Geometric standard deviation PbB	--	2.1	2.1
PbB_0	Baseline PbB	µg/dl	2.2	2.2
IR_s	Soil ingestion rate (including soil-derived indoor dust)	g/day	--	--
IR_{s+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	0.05	0.05
W_s	Weighting factor; fraction of IR_{s+D} ingested as outdoor soil	--	1.00	1.00
K_{SD}	Mass fraction of soil in dust	--	0.70	0.70
$AF_{s,D}$	Absorption fraction (same for soil and dust)	--	0.12	0.12
$EF_{s,D}$	Exposure frequency (same for soil and dust)	days/yr	250	250

Key:

days/yr = Days per year.
 g/day = Grams per day.
 mg/kg = Milligrams per kilogram.
 µg/day = Micrograms per day.
 µg/dl = Micrograms per deciliter.

Source: Adapted from a spreadsheet developed by the U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee (EPA 1996b). See text for discussion of parameters.

Table 3-18

TOXICITY INDICES FOR CARCINOGENIC EFFECTS OF COPCs
JENNISON-WRIGHT SITE, GRANITE CITY, ILLINOIS

Chemical	Cancer Class	Exposure Route	Slope Factor (mg/kg-day) ⁻¹	Target Organ	Tumor Type	Basis Species	Basis Exposure Route	Reference Source
Arsenic	A	Inhalation	1.5E+01	Lung	Lung cancer	Human, male	Inhalation, occupational exposure	IRIS
		Oral	1.5E+00	Skin	Skin cancer	Human, male	Drinking water	IRIS
Benzene	A	Inhalation	2.9E-02	Blood	Leukemia	Human	Inhalation, occupational exposure	IRIS
		Oral	2.9E-02	Blood	Leukemia	Human	Inhalation, occupational exposure	IRIS
Benzo[a]anthracene	B2	Inhalation	3.1E-01	--	--	--	--	Other EPA Docs.
		Oral	7.3E-01	--	--	--	--	NCEA
Benzo[a]pyrene	B2	Inhalation	3.1E+00	Respiratory tract	--	Hamster	Inhalation	IRIS
		Oral	7.3E+00	Forestomach	--	CFW and SWR/J Swill mice	Oral, diet	IRIS
Benzo[b]fluoranthene	B2	Inhalation	3.1E-01	--	--	--	--	Other EPA Docs.
		Oral	7.3E-01	--	--	--	--	NCEA
Benzo[k]fluoranthene	B2	Inhalation	3.1E-02	--	--	--	--	Other EPA Docs.
		Oral	7.3E-02	--	--	--	--	NCEA
Beryllium	B2	Inhalation	8.4E+00	Lung	--	Human	Inhalation, occupational exposure	IRIS
		Oral	NA	--	--	--	--	Withdrawn
Carbazole	B2	Inhalation	2.0E-02	Liver	Tumors	Mouse	Diet	Oral SF

Source: Ecology and Environment, Inc. 1999

Key at end of table

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Table 3-18

**TOXICITY INDICES FOR CARCINOGENIC EFFECTS OF COPCs
JENNISON-WRIGHT SITE, GRANITE CITY, ILLINOIS**

Chemical	Cancer Class	Exposure Route	Slope Factor (mg/kg-day) ⁻¹	Target Organ	Tumor Type	Basis Species	Basis Exposure Route	Reference Source
Carbazole	B2	Oral	2.0E-02	Liver	Tumors	Mouse	Diet	HEAST
Chloroform	B2	Inhalation	8.0E-02	Liver	Hepatocellular carcinoma	Mouse, B6C3F1, female	Gavage	IRIS
		Oral	6.1E-03	Kidney	All kidney tumors	Rat/Osborne-Mendel, male	Drinking water	IRIS
Chromium (VI)	A	Inhalation	4.2E+01	Lung	Lung cancer	Human	Inhalation, occupational exposure	IRIS
		Oral	NA	--	--	--	--	--
Chrysene	B2	Inhalation	3.1E-03	--	--	--	--	Other EPA Docs.
		Oral	7.3E-03	--	--	--	--	NCEA
Di(2-ethylhexyl)phthalate	B2	Inhalation	1.4E-02	--	--	--	--	Oral SF
		Oral	1.4E-02	Liver	Hepatocellular carcinoma and adenoma	Mouse/B6C3F1, male	Diet	IRIS
Dibenz[a,h]anthracene	B2	Inhalation	3.1E+00	--	--	--	--	Other EPA Docs.
		Oral	7.3E+00	--	--	--	--	NCEA
Dichloroethane, 1,2-	B2	Inhalation	9.1E-02	Circulatory system	--	Rat/Osborne-Mendel, male	Gavage	IRIS
		Oral	9.1E-02	Circulatory system	Hemangiosarcomas	Rat/Osborne-Mendel, male	Gavage	IRIS
Hexachlorocyclohexane, alpha-	B2	Inhalation	6.3E+00	Liver	Hepatic nodules and hepatocellular carcinomas	Mouse/dd, male	Diet	IRIS
		Oral	6.3E+00	Liver	Hepatic nodules and hepatocellular carcinomas	Mouse/dd, male	Diet	IRIS

Table 3-18

**TOXICITY INDICES FOR CARCINOGENIC EFFECTS OF COPCs
JENNISON-WRIGHT SITE, GRANITE CITY, ILLINOIS**

Chemical	Cancer Class	Exposure Route	Slope Factor (mg/kg-day) ⁻¹	Target Organ	Tumor Type	Basis Species	Basis Exposure Route	Reference Source
Indeno[1,2,3-cd]pyrene	B2	Inhalation	3.1E-01	--	--	--	--	Other EPA Docs.
		Oral	7.3E-01	--	--	--	--	NCEA
Methylene chloride	B2	Inhalation	1.6E-03	Liver, lung	Combined adenomas and carcinomas	Mouse/B6C3F1, female	Inhalation	IRIS
		Oral	7.5E-03	Liver	Hepatocellular adenomas or carcinomas (NTP) and hepatocellular cancer and neoplastic nodules (NCA)	Mouse/B6C3F1 (female, NTP; male, NCA)	Inhalation (NTP); drinking water (NCA)	IRIS
Methylphenol, 2-	C	Inhalation	NA	--	--	--	--	--
		Oral	NA	--	--	--	--	--
Pentachlorophenol	B2	Inhalation	1.2E-01	Liver, cardiovascular system	Hepatocellular adenoma/carcinoma, pheochromocytoma/malignant pheochromocytoma, hemangiosarcoma/hemangioma	Mouse/B6C3F1, female	Diet	Oral SF
		Oral	1.2E-01	Liver, cardiovascular system	Hepatocellular adenoma/carcinoma, pheochromocytoma/malignant pheochromocytoma, hemangiosarcoma/hemangioma	Mouse/B6C3F1, female	Diet	IRIS
TCDD 2,3,7,8	B2	Inhalation	1.5E+05	Respiratory system, liver	--	Rat	Diet	HEAST
		Oral	1.5E+05	Respiratory system, liver	--	Rat	Diet	HEAST
Trichloroethene	B2	Inhalation	6.0E-03	Liver	--	Mouse	Inhalation	NCEA
		Oral	1.1E-02	Liver	--	Mouse	Gavage	NCEA

Table 3-18

Key:

HEAST	=	EPA's Health Effects Assessment Summary Tables.
IRIS	=	EPA's Integrated Risk Information System.
NA	=	Not available.
NCA	=	National Coffee Association.
NCEA	=	EPA's National Center for Environmental Assessment.
NTP	=	National Toxicology Program.
OHEA	=	EPA's Office of Health and Environmental Assessment.
Other EPA Docs.	=	EPA criteria documents such as drinking water criteria documents, drinking water Health Advisory summaries, ambient water quality criteria documents, and air quality criteria documents.
SF	=	Slope Factor.

Source: Ecology and Environment, Inc., 1999.

Table 3-19

TOXICITY INDICES FOR NONCARCINOGENIC EFFECTS OF COPCs
JENNISON-WRIGHT SITE, GRANITE CITY, ILLINOIS

Chemical	Exposure Route	RfD Type	Reference Dose (mg/kg-day)	Uncert Factor	Mod Factor	Confidence Level	Target Organ	Critical Effect	Study Description	Reference Source	Date
Acenaphthene	Inhalation	Chronic	6.0E-02	--	--	--	Liver	Hepatotoxicity	--	Chr. Oral RfD	
		Subchronic	6.0E-01	--	--	--	Liver	Hepatotoxicity	--	Subchr. Oral RfD	
	Oral	Chronic	6.0E-02	3000	1	Low	Liver	Hepatotoxicity	Mouse, oral subchronic study	IRIS	4/1/94
		Subchronic	6.0E-01	300	--	--	Liver	Hepatotoxicity	--	HEAST	5/31/95
Arsenic	Inhalation	Chronic	NA	--	--	--	--	--	--	--	
		Subchronic	NA	--	--	--	--	--	--	--	
	Oral	Chronic	3.0E-04	3	1	Medium	Skin	Hyperpigmentation, keratosis and possible vascular complications	Human chronic oral exposure	IRIS	3/1/93
		Subchronic	3.0E-04	3	--	--	Skin	Keratosis	--	HEAST	5/31/95
Benzene	Inhalation	Chronic	1.7E-03	1000	--	--	--	Hematopoietic effects	Mouse, subchronic inhalation study	NCEA	
		Subchronic	1.7E-02	100	--	Medium	--	Hematopoietic effects	Mouse, subchronic inhalation study	NCEA	
	Oral	Chronic	3.0E-03	--	--	--	--	--	--	NCEA	
		Subchronic	3.0E-03	--	--	--	--	--	--	NCEA	
Benzo[a]anthracene	Inhalation	Chronic	NA	--	--	--	--	--	--	--	
		Subchronic	NA	--	--	--	--	--	--	--	
	Oral	Chronic	NA	--	--	--	--	--	--	--	
		Subchronic	NA	--	--	--	--	--	--	--	
Benzo[a]pyrene	Inhalation	Chronic	NA	--	--	--	--	--	--	--	

Table 3-19

TOXICITY INDICES FOR NONCARCINOGENIC EFFECTS OF COPCs
JENNISON-WRIGHT SITE, GRANITE CITY, ILLINOIS

Chemical	Exposure Route	RfD Type	Reference Dose (mg/kg-day)	Uncert Factor	Mod Factor	Confidence Level	Target Organ	Critical Effect	Study Description	Reference Source	Date
Benzo[a]pyrene	Inhalation	Subchronic	NA	--	--	--	--	--	--	--	--
	Oral	Chronic	NA	--	--	--	--	--	--	--	--
		Subchronic	NA	--	--	--	--	--	--	--	--
Benzo[b]fluoranthene	Inhalation	Chronic	NA	--	--	--	--	--	--	--	--
		Subchronic	NA	--	--	--	--	--	--	--	--
	Oral	Chronic	NA	--	--	--	--	--	--	--	--
		Subchronic	NA	--	--	--	--	--	--	--	--
Benzo[k]fluoranthene	Inhalation	Chronic	NA	--	--	--	--	--	--	--	--
		Subchronic	NA	--	--	--	--	--	--	--	--
	Oral	Chronic	NA	--	--	--	--	--	--	--	--
		Subchronic	NA	--	--	--	--	--	--	--	--
Beryllium	Inhalation	Chronic	NA	--	--	--	--	--	--	--	--
		Subchronic	NA	--	--	--	--	--	--	--	--
	Oral	Chronic	2.0E-03	100	1	Low	--	No adverse effects	Rat, chronic oral bioassay	IRIS	2/1/93
		Subchronic	2.0E-03	100	--	--	--	None observed	--	HEAST	7/1/97
Carbazole	Inhalation	Chronic	NA	--	--	--	--	--	--	--	--
		Subchronic	NA	--	--	--	--	--	--	--	--
	Oral	Chronic	NA	--	--	--	--	--	--	--	--
		Subchronic	NA	--	--	--	--	--	--	--	--
Chloroform	Inhalation	Chronic	1.1E-02	300	--	Medium	Liver	Necrosis	Rat, subchronic inhalation study	NCEA	8/25/93

Table 3-19

**TOXICITY INDICES FOR NONCARCINOGENIC EFFECTS OF COPCs
JENNISON-WRIGHT SITE, GRANITE CITY, ILLINOIS**

Chemical	Exposure Route	RfD Type	Reference Dose (mg/kg-day)	Uncert Factor	Mod Factor	Confidence Level	Target Organ	Critical Effect	Study Description	Reference Source	Date
Chloroform	Inhalation	Subchronic	1.1E-02	--	--	--	Liver	Necrosis	--	Chr. Inhl RfD	
	Oral	Chronic	1.0E-02	1000	1	Medium	Liver	Fatty cyst formation in liver	Dog, chronic oral bioassay	IRIS	9/1/92
		Subchronic	1.0E-02	1000	--	--	Liver	Lesions	Dog oral capsule 7.5 years	HEAST	5/31/95
Chromium(III), soluble salts	Inhalation	Chronic	NA	--	--	--	--	--	--	--	
		Subchronic	NA	--	--	--	--	--	--	--	
	Oral	Chronic	1.5E+00	--	--	--	--	None observed	--	IRIS	9/1/98
		Subchronic	1.5E+00	1000	--	--	--	None observed	Rat diet	IRIS	9/1/98
Chromium(VI)	Inhalation	Chronic	2.9E-05	100	--	Low	Respiratory tract	Diffuse nasal symptoms	Human occupational study	IRIS	3/1/99
		Subchronic	2.9E-05	100	--	Low	--	--	--	IRIS	3/1/99
	Oral	Chronic	3.0E-03	500	1	Low	--	No effects reported	Rat, 1-year drinking water study	IRIS	3/1/99
		Subchronic	2.0E-02	100	--	--	--	None observed	Rat drinking water	HEAST	5/31/95
Chrysene	Inhalation	Chronic	NA	--	--	--	--	--	--	--	
		Subchronic	NA	--	--	--	--	--	--	--	
	Oral	Chronic	NA	--	--	--	--	--	--	--	
		Subchronic	NA	--	--	--	--	--	--	--	
Di(2-ethylhexyl)phthalate	Inhalation	Chronic	2.9E-03	100	--	Low	Lung	Increased lung weight, histological alterations	Rat, inhalation study	NCEA	3/18/96
		Subchronic	2.9E-03	--	--	--	Lung	Increased lung weight, histological alterations	--	Chr. Inhl RfD	
	Oral	Chronic	2.0E-02	1000	1	Medium	Liver	Increased relative liver weight	Guinea pig, subchronic to chronic oral bioassay	IRIS	5/1/91

Table 3-19

TOXICITY INDICES FOR NONCARCINOGENIC EFFECTS OF COPCs
JENNISON-WRIGHT SITE, GRANITE CITY, ILLINOIS

Chemical	Exposure Route	RfD Type	Reference Dose (mg/kg-day)	Uncert Factor	Mod Factor	Confidence Level	Target Organ	Critical Effect	Study Description	Reference Source	Date
Di(2-ethylhexyl)phthalate	Oral	Subchronic	2.0E-02	--	--	--	Liver	Increased relative liver weight	--	Chr. Oral RfD	
Dibenz[a,h]anthracene	Inhalation	Chronic	NA	--	--	--	--	--	--	--	
		Subchronic	NA	--	--	--	--	--	--	--	
	Oral	Chronic	NA	--	--	--	--	--	--	--	
		Subchronic	NA	--	--	--	--	--	--	--	
Dichloroethane, 1,2-	Inhalation	Chronic	2.9E-03	--	--	--	--	--	--	Other EPA Docs.	
		Subchronic	2.9E-03	--	--	--	--	--	--	Chr. Inhl RfD	
	Oral	Chronic	NA	--	--	--	--	--	--	--	
		Subchronic	NA	--	--	--	--	--	--	--	
Dimethylphenol, 2,4-	Inhalation	Chronic	2.0E-02	--	--	--	Whole body	Clinical signs (lethargy, prostration, and ataxia) and hematological changes	--	Chr. Oral RfD	
		Subchronic	2.0E-01	--	--	--	Nervous System	Effects	--	Subchr. Oral RfD	
	Oral	Chronic	2.0E-02	3000	1	Low	Whole body	Clinical signs (lethargy, prostration, and ataxia) and hematological changes	Mouse, subchronic oral gavage study	IRIS	11/1/90
		Subchronic	2.0E-01	300	--	--	Nervous System	Effects	--	HEAST	3/31/93
Ethylbenzene	Inhalation	Chronic	2.9E-01	300	1	Low	Whole body	Developmental toxicity	Rat and rabbit, developmental inhalation studies	IRIS	3/1/91

Table 3-19

TOXICITY INDICES FOR NONCARCINOGENIC EFFECTS OF COPCs
JENNISON-WRIGHT SITE, GRANITE CITY, ILLINOIS

Chemical	Exposure Route	RfD Type	Reference Dose (mg/kg-day)	Uncert Factor	Mod Factor	Confidence Level	Target Organ	Critical Effect	Study Description	Reference Source	Date
Ethylbenzene	Inhalation	Subchronic	2.9E-01	--	--	--	Whole body	Developmental toxicity	--	Chr. Inhl RfD	
	Oral	Chronic	1.0E-01	1000	1	Low	Liver	Liver and kidney toxicity	Rat, subchronic to chronic oral bioassay	IRIS	6/1/91
		Subchronic	1.0E-01	--	--	--	Liver	Liver and kidney toxicity	--	Chr. Oral RfD	
Hexachlorocyclohexane, alpha-	Inhalation	Chronic	NA	--	--	--	--	--	--	--	
		Subchronic	NA	--	--	--	--	--	--	--	
	Oral	Chronic	NA	--	--	--	--	--	--	--	
		Subchronic	NA	--	--	--	--	--	--	--	
Indeno[1,2,3-cd]pyrene	Inhalation	Chronic	NA	--	--	--	--	--	--	--	
		Subchronic	NA	--	--	--	--	--	--	--	
	Oral	Chronic	NA	--	--	--	--	--	--	--	
		Subchronic	NA	--	--	--	--	--	--	--	
Manganese (diet)	Inhalation	Chronic	1.4E-05	1000	1	Medium	Nervous system	Impairment of neurobehavioral function	Occupational exposure to manganese dioxide	IRIS	12/1/93
		Subchronic	1.4E-05	--	--	--	Nervous system	Impairment of neurobehavioral function	--	Chr. Inhl RfD	
	Oral	Chronic	1.4E-01	1	1	Varied	Central nervous system	CNS effects	Human chronic ingestion data	IRIS	6/1/95
		Subchronic	1.4E-01	1	--	--	Central nervous system	CNS effects	--	HEAST	5/31/95
Manganese (water)	Inhalation	Chronic	1.4E-05	1000	1	Medium	Nervous system	Impairment of neurobehavioral function	Occupational exposure to manganese dioxide	IRIS	12/1/93

Table 3-19

TOXICITY INDICES FOR NONCARCINOGENIC EFFECTS OF COPCs
JENNISON-WRIGHT SITE, GRANITE CITY, ILLINOIS

Chemical	Exposure Route	RfD Type	Reference Dose (mg/kg-day)	Uncert Factor	Mod Factor	Confidence Level	Target Organ	Critical Effect	Study Description	Reference Source	Date
Manganese (water)	Inhalation	Subchronic	1.4E-05	--	--	--	Nervous system	Impairment of neurobehavioral function	--	Chr. Inhl RfD	
	Oral	Chronic	4.7E-02	1	1	Varied	Central nervous system	CNS effects	Human chronic ingestion data	IRIS	3/1/99
		Subchronic	4.7E-02	1	--	--	Central nervous system	CNS effects	--	IRIS	3/1/99
Methylene chloride	Inhalation	Chronic	8.6E-01	100	--	--	Liver	Liver toxicity	Rat, 2-year inhalation study	HEAST	5/31/95
		Subchronic	8.6E-01	--	--	--	Liver	Liver toxicity	--	Chr. Inhl RfD	
	Oral	Chronic	6.0E-02	100	1	Medium	Liver	Liver toxicity	Rat, 2-year drinking water bioassay	IRIS	3/1/88
		Subchronic	6.0E-02	--	--	--	Liver	Liver toxicity	--	Chr. Oral RfD	
Methylphenol, 2-	Inhalation	Chronic	5.0E-02	--	--	--	Whole body	Decreased body weights and neurotoxicity	--	Chr. Oral RfD	
		Subchronic	5.0E-01	--	--	--	Whole body	--	--	Subchr. Oral RfD	
	Oral	Chronic	5.0E-02	1000	1	Medium	Whole body	Decreased body weights and neurotoxicity	Rat, 90-day oral subchronic neurotoxicity study	IRIS	9/1/90
		Subchronic	5.0E-01	100	--	--	Whole body	--	Rat oral gavage	HEAST	5/31/95
Naphthalene	Inhalation	Chronic	8.6E-04	--	--	--	--	--	--	Chr. Oral RfD	
		Subchronic	8.6E-04	--	--	--	--	--	--	Chr. Oral RfD	
	Oral	Chronic	2.0E-02	1000	--	--	--	--	Rat, subchronic gavage study	IRIS	3/1/99

Table 3-19

TOXICITY INDICES FOR NONCARCINOGENIC EFFECTS OF COPCs
JENNISON-WRIGHT SITE, GRANITE CITY, ILLINOIS

Chemical	Exposure Route	RfD Type	Reference Dose (mg/kg-day)	Uncert Factor	Mod Factor	Confidence Level	Target Organ	Critical Effect	Study Description	Reference Source	Date
Naphthalene	Oral	Subchronic	2.0E-02	--	--	--	--	--	--	Chr. Oral RfD	3/1/99
Pentachlorophenol	Inhalation	Chronic	3.0E-02	--	--	--	Liver, kidney	Liver and kidney pathology	--	Chr. Oral RfD	
		Subchronic	3.0E-02	--	--	--	Fetus	Fetotoxicity	--	Subchr. Oral RfD	
	Oral	Chronic	3.0E-02	100	1	Medium	Liver, kidney	Liver and kidney pathology	Rat, oral chronic study	IRIS	2/1/93
		Subchronic	3.0E-02	100	--	--	Fetus	Fetotoxicity	--	HEAST	3/31/93
Phenol	Inhalation	Chronic	6.0E-01	--	--	--	Whole body	Reduced fetal body weight in rats	--	Chr. Oral RfD	
		Subchronic	6.0E-01	--	--	--	Fetus	Decreased weight	--	Subchr. Oral RfD	
	Oral	Chronic	6.0E-01	100	1	Low	Whole body	Reduced fetal body weight in rats	Rat, oral developmental study	IRIS	2/1/90
		Subchronic	6.0E-01	100	--	--	Fetus	Decreased weight	--	HEAST	3/31/93
TCDD 2,3,7,8	Inhalation	Chronic	NA	--	--	--	--	--	--	--	
		Subchronic	NA	--	--	--	--	--	--	--	
	Oral	Chronic	NA	--	--	--	--	--	--	--	
		Subchronic	NA	--	--	--	--	--	--	--	
Thallium	Inhalation	Chronic	NA	--	--	--	--	--	--	--	
		Subchronic	NA	--	--	--	--	--	--	--	
	Oral	Chronic	8.0E-05	3000	--	Low	Liver	Increased levels of SGOT and LDH	Rat oral subchronic study	IRIS	3/1/99
		Subchronic	8.0E-04	300	--	--	Liver	Increased SGOT	--	HEAST	7/1/97

Table 3-19

TOXICITY INDICES FOR NONCARCINOGENIC EFFECTS OF COPCs
JENNISON-WRIGHT SITE, GRANITE CITY, ILLINOIS

Chemical	Exposure Route	RfD Type	Reference Dose (mg/kg-day)	Uncert Factor	Mod Factor	Confidence Level	Target Organ	Critical Effect	Study Description	Reference Source	Date
Toluene	Inhalation	Chronic	1.1E-01	300	1	Medium	Brain	Neurological effects	Human occupational study	IRIS	8/1/92
		Subchronic	2.9E-01	--	--	--	Brain	Neurological effects	--	NCEA	
	Oral	Chronic	2.0E-01	1000	1	Medium	Liver, kidney	Changes in liver and kidney weights	Rat, 3-week gavage study	IRIS	4/1/94
		Subchronic	2.0E-01	100	--	--	Liver	Altered weight	--	HEAST	3/31/93
Trichloroethene	Inhalation	Chronic	6.0E-03	--	--	--	--	--	--	Chr. Oral RfD	
		Subchronic	6.0E-03	--	--	--	--	--	--	Chr. Oral RfD	
	Oral	Chronic	6.0E-03	--	--	--	--	--	--	Other EPA Docs.	
		Subchronic	6.0E-03	--	--	--	--	--	--	Chr. Oral RfD	

Table 3-19

Key:

CNS	= Central Nervous System.
HEAST	= EPA's Health Effects Assessment Summary Tables.
IRIS	= EPA's Integrated Risk Information System.
LDH	= Lactate Dehydrogenase (enzyme).
NA	= Not available.
NCEA	= EPA's National Center for Environmental Assessment.
OHEA	= EPA's Office of Health and Environmental Assessment.
Other EPA Docs.	= EPA criteria documents such as drinking water criteria documents, drinking water Health Advisory summaries, ambient water quality criteria documents, and air quality criteria documents.
RfD	= Reference dose.
SGOT	= Serum Glutamic-Oxaloacetic Transaminase (enzyme).

Source: Ecology and Environment, Inc., 1999.

Table 3-20 WEIGHT-OF-EVIDENCE CATEGORIES FOR CHEMICAL CARCINOGENICITY HUMAN HEALTH RISK EVALUATION JENNISON-WRIGHT SITE	
Group	Description
A	Human Carcinogen
B	Probable Human Carcinogen: B1: Limited human data are available. B2: Sufficient evidence in animals or no evidence in humans.
C	Possible Human Carcinogen
D	Not Classifiable
E	Evidence of Noncarcinogenicity for Humans

Source: EPA 1986.

Table 3-21											
SUMMARY OF RISK ESTIMATES JENNISON-WRIGHT SITE GRANITE CITY, ILLINOIS											
Scenario	Receptor	Age Group	Location	Pathway	Total HI	% HI by Pathway	HQ>1 by Chemical (% of total)	Total Cancer Risk	% CR by Pathway	CR> 10 ⁻⁶ by Chemical (% of total)	
Current Exposure Scenarios											
1	Current Site Visitors	Adolescent	On site	Ingestion of Soil	0.024	18.6	None	3.8E-04	49.10	TCDD-TEQ (82%)	
				Dermal Absorption from Soil	0.082	62.9		3.9E-04	50.85	Benzo(a)pyrene (10%)	
				Inhalation of Vapor from Soil	0.021	16.4		4.2E-07	0.05	Benzo(a)anthracene (2%)	
				Inhalation of Fugitive Dust	0.0027	2.1		8.3E-09	0.0011	Dibenz(a,h)anthracene (2%)	
				Receptor/Pathway Total	0.13	100.0		7.7E-04	100.0	Benzo(b)fluoranthene (1%)	
										Carbazole (<1%)	
										Pentachlorophenol (<1%)	
										Indeno(1,2,3-cd)pyrene (<1%)	
2	Current Nearby Residents	Adult/Child (Integrated)	Off site	Inhalation of Vapor from Soil	0.355	80.4	None	2.6E-05	96.3	TCDD-TEQ (76%)	
				Inhalation of Fugitive Dust	0.087	19.6		1.0E-06	3.7	Pentachlorophenol (6%)	
				Receptor/Pathway Total	0.4	100.0		2.7E-05	100.0	Carbazole (7%)	
											Benzo(a)pyrene (4%)
		Child	Off site	Inhalation of Vapor from Soil	1.5	90.1	Naphthalene (90%)	2.3E-05	98.3	TCDD-TEQ (76%)	
				Inhalation of Fugitive Dust	0.17	9.9		3.9E-07	1.7	Pentachlorophenol (6%)	
Receptor/Pathway Total	1.7			100.0	2.3E-05	100.0		Carbazole (7.5%)			
Future Exposure Scenarios											
3	Future Permanent Site Worker	Adult	On site	Ingestion of Soil	0.03	3.6	None	2.0E-03	19.4	TCDD-TEQ (86%)	
				Dermal Absorption from Soil	0.41	49.4		8.1E-03	80.4	Benzo(a)pyrene (8%)	
				Inhalation of Vapor from Soil	0.34	41.1		1.4E-05	0.1	Benzo(a)anthracene (2%)	
				Inhalation of Fugitive Dust	0.05	6.0		6.0E-07	0.006	Dibenz(a,h)anthracene (1%)	
				Receptor/Pathway Total	0.8	100.0		1.0E-02	100.0	Benzo(b)fluoranthene (<1%)	

<p align="center">Table 3-21</p> <p align="center">SUMMARY OF RISK ESTIMATES</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>										
Scenario	Receptor	Age Group	Location	Pathway	Total HI	% HI by Path- way	HIQ>1 by Chemical (% of total)	Total Cancer Risk	% CR by Path- way	CR> 10 ⁻⁶ by Chemical (% of total)
Future Exposure Scenarios (Cont.)										
3	Future Permanent Site Worker (Cont.)	Adult (Cont.)	On site (Cont.)							Pentachlorophenol (<1%) Indeno(1,2,3-cd)pyrene (<1%) Benzo(k)fluoranthene (<1%) Carbazole (<1%) Benzene (<1%) Chrysene (<1%)
4	Future Permanent Site Worker	Adult	22nd St. Lagoon	Ingestion of Water	46.7	--	Benzene (46%) Naphthalene (22%) 2,4-Dimethylphenol (16%) 4-Methylphenol (9%) Manganese (3%)	2.4E-03	--	Benzene (28%) Pentachlorophenol (25%) Benzo(a)anthracene (21%) Benzo(b)fluoranthene (19%) Arsenic (5%) Benzo(k)fluoranthene (1%) Chrysene (<1%)
			Area H	Ingestion of Water	0.2	--	None	2.0E-05	--	Pentachlorophenol (99%)
			Jennite Pit	Ingestion of Water	0.3	--	None	1.8E-05	--	Arsenic (94%)
			PCP Process Area	Ingestion of Water	31.9	--	Pentachlorophenol (90%) Arsenic (7%) Manganese (3%)	3.7E-02	--	Pentachlorophenol (99%) Arsenic (<1%) alpha-BHC (<1%)
5	Future Construction Worker	Adult	On site	Ingestion of Soil	0.3	0.7	Naphthalene (94%)	1.4E-04	65.6	TCDD-TEQ (87%)
				Dermal Absorption from Soil	0.5	1.1	Benzene (3%)	6.2E-05	28.3	Benzo(a)pyrene (7%)
				Inhalation of Vapor from Soil	42.1	97.5		1.3E-05	6.1	Benzo(a)anthracene (2%)

<p align="center">Table 3-21</p> <p align="center">SUMMARY OF RISK ESTIMATES</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>										
Scenario	Receptor	Age Group	Location	Pathway	Total HI	% HI by Pathway	HQ>1 by Chemical (% of total)	Total Cancer Risk	% CR by Pathway	CR> 10 ⁻⁶ by Chemical (% of total)
Future Exposure Scenarios (Cont.)										
5	Future Construction Worker (Cont.)	Adult (Cont.)	On site (Cont.)	Inhalation of Fugitive Dust	0.3	0.8		2.6E-08	0.01	Dibenz(a,h)anthracene (1%)
				Receptor/Pathway Total	43.2	100.0		2.2E-04	100.0	Benzo(b)fluoranthene (<1%) Benzene (<1%)
6	Future Nearby Residents	Adult/Child (Integrated)	Off site	Inhalation of Vapor from Soil	0.5	89.3	None	2.5E-05	96.5	TCDD-TEQ (79%)
				Inhalation of Fugitive Dust	0.1	10.7		9.1E-07	3.5	Benzene (10%)
				Receptor/Pathway Total	0.6	100.0		2.6E-05	100.0	
		Child	Off site	Inhalation of Vapor from Soil	1.8	93.5	Naphthalene (90%)	2.2E-05	98.4	TCDD-TEQ (79%)
				Inhalation of Fugitive Dust	0.1	6.5		3.6E-07	1.6	Benzene (10%)
				Receptor/Pathway Total	1.9	100.0		2.4E-05	100.0	
7	Future Nearby Residents During Construction	Adult/Child (Integrated)	Off site	Inhalation of Vapor from Soil	44.7	99.4	Naphthalene (96%)	1.4E-05	99.8	TCDD-TEQ (79%)
				Inhalation of Fugitive Dust	0.3	0.6	Benzene (3%)	2.2E-08	0.2	Benzene (10%)
				Receptor/Pathway Total	45.0	100.0		1.4E-05	100.0	
		Child	Off site	Inhalation of Vapor from Soil	114.4	99.35	Naphthalene (96%)	3.7E-05	99.8	TCDD-TEQ (79%)
				Inhalation of Fugitive Dust	0.7	0.65	Benzene (3%)	5.6E-08	0.2	Benzene (10%)
				Receptor/Pathway Total	115.1	100.0		3.7E-05	100.0	Benzo(a)pyrene (3%)

Key:

CR = Cancer risk.
 HI = Hazard index.
 HQ = Hazard quotient.
 TEQ = Toxic equivalent.

<p>Table 3-22</p> <p>RESULTS OF LEAD MODELING</p> <p>JENNISON-WRIGHT SITE</p> <p>GRANITE CITY, ILLINOIS</p>		
Case	Site-Wide Average	Maximum Detected Value
Child Visitor		
Geometric Mean Blood Lead Level ($\mu\text{g}/\text{dl}$)	3.4	3.5
Estimated Percent of Cases above 10 $\mu\text{g}/\text{dl}$	1.03	1.16
Adult Worker		
Estimated Fetal Blood Lead Concentration ($\text{PbB}_{\text{fetal}, 0.95}$)	7.5	9.6
Risk-Based Remediation Goal for Soil Based on Target of 10- $\mu\text{g}/\text{dl}$ Blood Lead (mg/kg)	656	656

See Appendix I for detailed results of IEUBK model for lead in children.

Source: Review Workgroup for Lead, Adult Lead Committee (EPA 1996b). See text for discussion of parameters.

<p>Table 3-23</p> <p>PLANT SPECIES IDENTIFIED AT THE JW SITE</p> <p>JENNISON-WRIGHT SITE</p> <p>GRANITE CITY, ILLINOIS</p>	
Common Name	Scientific Name
Balsam Ragwort	<i>Senecio pauperculus</i>
Common Catalpa	<i>Catalpa tomentosa</i>
Hairy Goldenrod	<i>Solidago hispida</i>
Long-Leafed Spadwell	<i>Veronica longifolia</i>
Partridge Pea	<i>Cassia fasciculata</i>
Pumpkin Ash	<i>Fraxinus tomentosa</i>
White Ash	<i>Fraxinus americana</i>

<p style="text-align: center;">Table 3-24</p> <p style="text-align: center;">WILDLIFE LIKELY TO OCCUR IN THE VICINITY OF THE JW SITE</p> <p style="text-align: center;">JENNISON-WRIGHT SITE</p> <p style="text-align: center;">GRANITE CITY, ILLINOIS</p>	
Common Name	Scientific Name
Avian Species	
Black Crowned Night Heron	<i>Nyctanassa nycticorax</i>
Cattle Egret	<i>Bubulcus ibis</i>
Great Egret	<i>Cassmerodius albus</i>
Great Blue Heron	<i>Ciconiiformes ardeidae</i>
House Sparrow	<i>Passer domesticus</i>
Little Blue Heron	<i>Florida Caerulea</i>
Pipe-Billed Grebe	<i>Podilymbus podiceps</i>
Sand Piper	<i>Scolapacidae sp.</i>
Snowy Egret	<i>Egretta thula</i>
Yellow Crowned Night Heron	<i>Nyctanassa violacea</i>
Mammalian Species	
Raccoon	<i>Procyon lotor</i>
Opossum	<i>Didelphis sp.</i>
Short-Tailed Shrew	<i>Blarina brevicauda</i>

Source: Compiled by E & E from Tecic 1997.

<p>Table 3-25</p> <p>FISH SPECIES LIKELY TO OCCUR</p> <p>WITHIN A 1-MILE RADIUS OF THE JW SITE</p> <p>JENNISON-WRIGHT SITE</p> <p>GRANITE CITY, ILLINOIS</p>	
Common Name	Scientific Name
Bigmouth Shiner	<i>Notropis dorsalis</i>
Bluegill	<i>Lepomis macrochirus</i>
Bullhead Minnow	<i>Pimephales vigilax</i>
Channel Catfish	<i>Ictalurus natalis</i>
Common Carp	<i>Cyprinus carpio</i>
Creek Chub	<i>Semotilus atromaculatus</i>
Gizzard Shad	<i>Dorosoma cepedianum</i>
Golden Shiner	<i>Notemigonus crysoleucas</i>
Green Sunfish	<i>Lepomis cyanellus</i>
Mosquitofish	<i>Gambusia affinis</i>
Orangespotted Sunfish	<i>Lepomis humilis</i>
Red Shiner	<i>Notropis lustrans</i>
White Crappie	<i>Pomoxis annularis</i>
Yellow Bullhead	<i>Ictalurus natalis</i>

Source: Compiled by E & E from Sauer 1997.

3-87

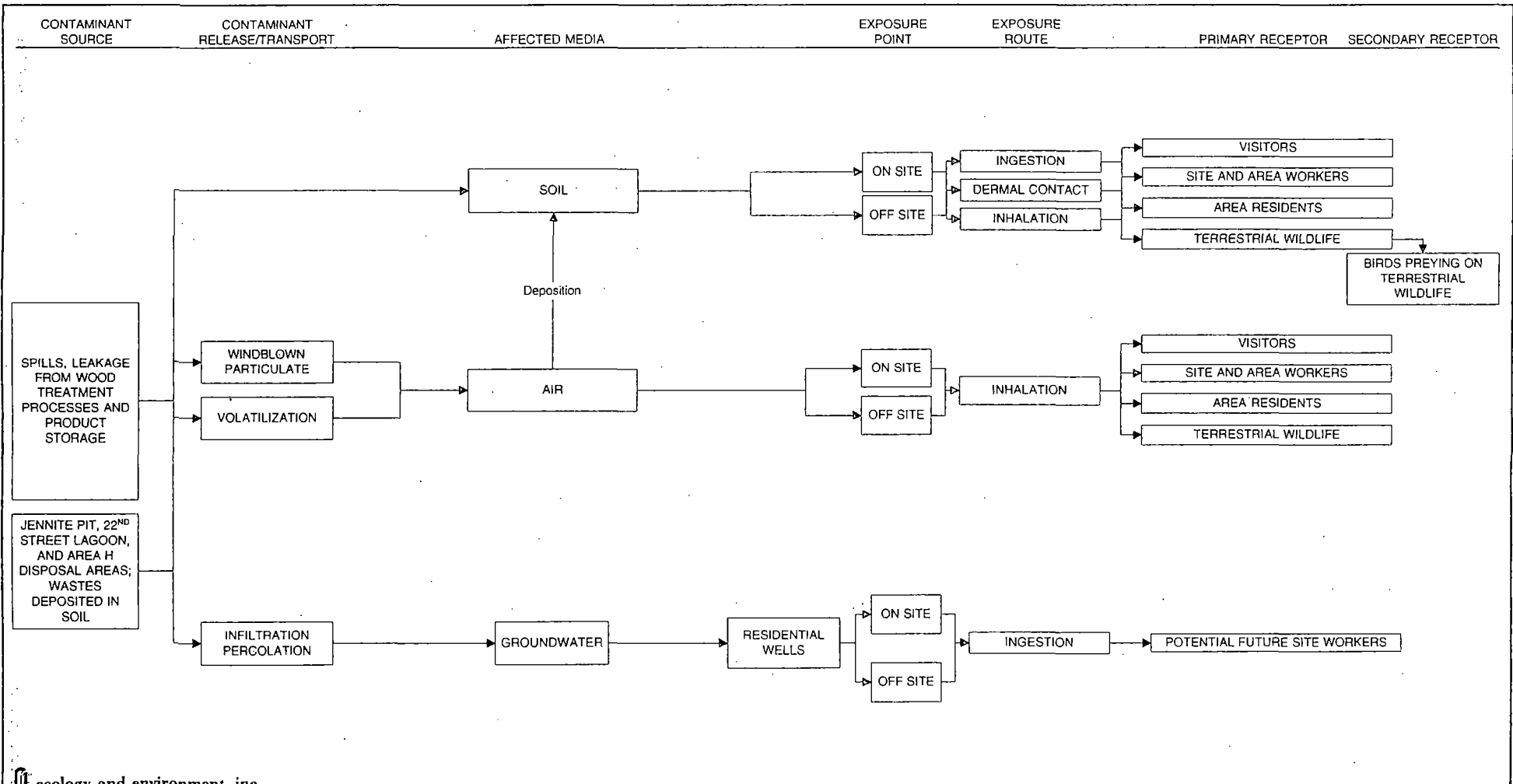
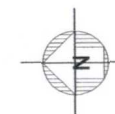
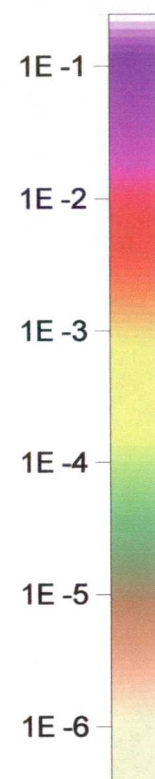


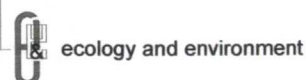
Figure 3-1 JENNISON-WRIGHT SRE CONCEPTUAL SITE MODEL
JENNISON-WRIGHT EE/CA
GRANITE CITY, ILLINOIS



ESTIMATED EXCESS
CANCER RISK



Color contours show the TOTAL
ESTIMATED CANCER RISKS from
all of the COPCs detected at each
surface soil sampling location.



LEGEND:

- FENCE
- CONCRETE SLAB OR PIT
- TRAM TRACKS
- SOIL SAMPLE LOCATION

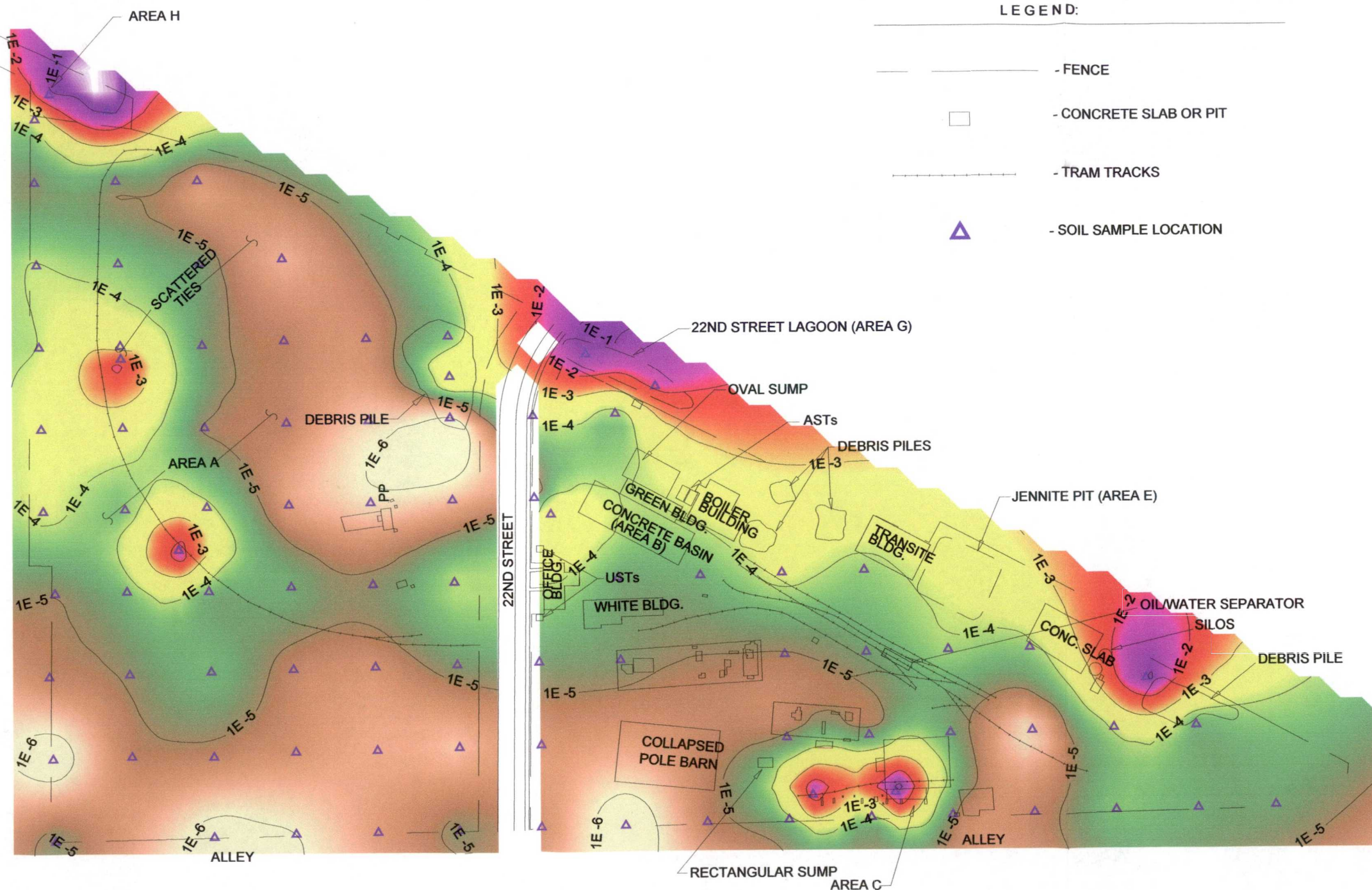


FIGURE 3-2 TOTAL ESTIMATED CANCER RISKS,
CURRENT SITE VISITOR SCENARIO.
JENNISON-WRIGHT SITE, GRANITE CITY, ILLINOIS

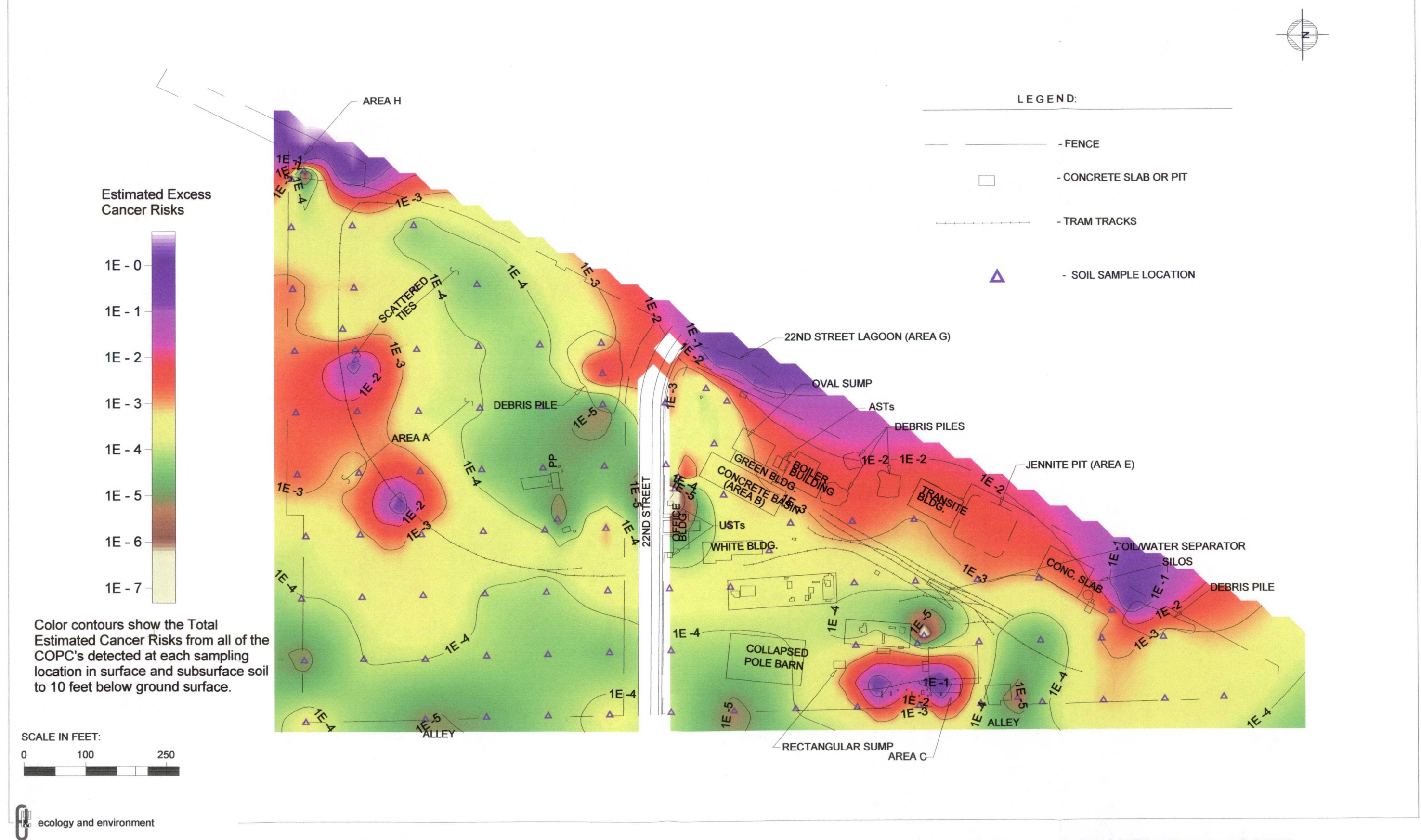
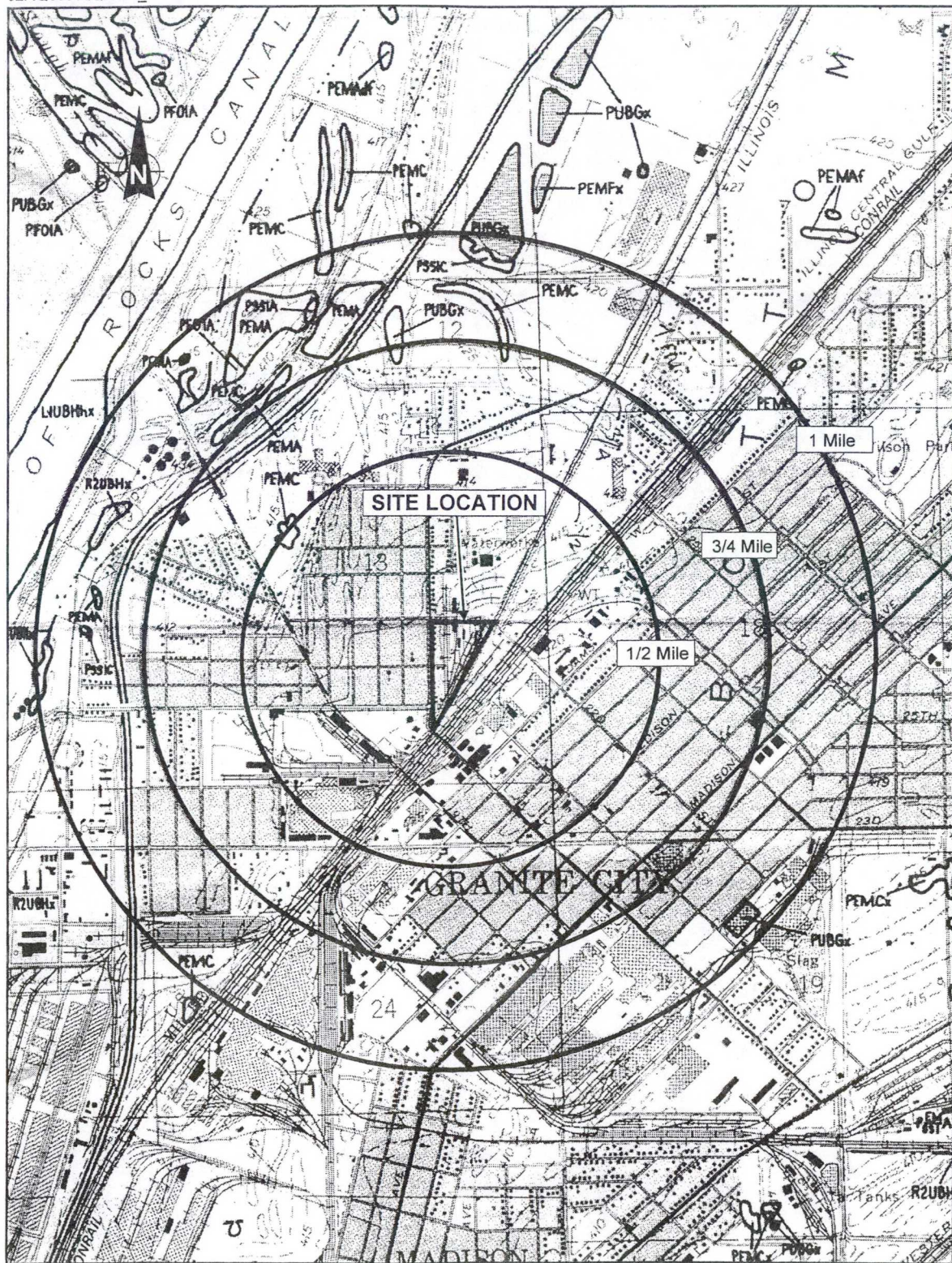


FIGURE 3-3 TOTAL ESTIMATED CANCER RISKS, FUTURE SITE WORKER SCENARIO. JENNISON-WRIGHT SITE, GRANITE CITY, ILLINOIS



SOURCE: National Wetlands Inventory 1993

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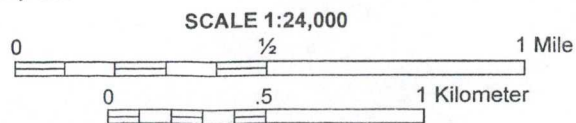


Figure 3-4 SENSITIVE HABITATS IN RELATION TO THE JENNISON WRIGHT SITE, GRANITE CITY, ILLINOIS

Key to wetland types identified in Figure 3-4:

- LIUBHhx = Lacustrine, limnetic, unconsolidated bottom, permanently flooded, diked/impounded, excavated.
- PEMA = Palustrine, emergent, temporarily flooded.
- PEMAF = Palustrine, emergent, temporarily flooded, farmed.
- PEMC = Palustrine, emergent, seasonally flooded.
- PEMCx = Palustrine, emergent, seasonally flooded, excavated.
- PEMFx = Palustrine, emergent, semi-permanently flooded, excavated.
- PFO1A = Palustrine, forested, broad-leaved deciduous, temporarily flooded.
- PSS1C = Palustrine, scrub-shrub, broad-leaved deciduous, seasonally flooded.
- PSS1A = Palustrine, scrub-shrub, broad-leaved deciduous, temporarily flooded.
- PUBGx = Palustrine, unconsolidated bottom, intermittently exposed, excavated.
- R2UBHx = Riverine, lower perennial, unconsolidated bottom, permanently flooded, excavated.

4

Removal Action Scope and Objective

SACM
Superfund Accelerated
Cleanup Model

According to the NCP, IEPA and EPA must decide whether the JW site poses a threat to public health or welfare or to the environment in order for a removal action to be conducted. If IEPA and EPA determine that a threat exists, a removal action can be implemented in order to abate, prevent, minimize, stabilize, mitigate, or eliminate the release or threat of release of hazardous substances. Based upon the sampling analytical results summarized in Section 2, and the results of the SRE presented in Section 3, a removal action appears to be warranted at the JW site.

The removal action proposed in this EE/CA will be implemented as part of the Superfund Accelerated Cleanup Model (SACM) process. The SACM process has been created within the framework of CERCLA and the NCP to expedite site cleanup and promote efficiency in the Superfund process.

4.1 Statutory Limits on Removal Actions

Section 300.415(b)(4) of 40 CFR Part 300 (the NCP) allows at least six months of lead time before cleanup must begin on a non-time-critical removal action, if such action is appropriate to the site conditions. In addition, the lead agency must conduct an EE/CA, or its equivalent, to identify and analyze removal alternatives for a site, pursuant to Section 300.415(b)(4)(i).

Section 300.415(b)(5) of the NCP stipulates that the cost and duration of a removal action be limited to \$2 million and 12 months, respectively. There are two types of exemptions to these statutory limits, in accordance with Section 104(c)(1), 42 U.S.C. 9604(c)(1) of CERCLA: 1) the "emergency" waiver; and 2) the "consistency" waiver. The "emergency" waiver provides additional funding or extends the removal action duration when continued response actions are required to prevent, limit, or mitigate an immediate risk to public health or welfare or to the environment. The "consistency" waiver provides additional funding or extends the removal action time frame to implement a removal action that is otherwise appropriate and consistent with the final response action to be taken. The statutory limits on removal actions apply only to fund-financed actions. If potentially

4. Removal Action Scope and Objectives

responsible parties perform the removal action, the limits do not apply. The action at the JW site would be a fund-financed action.

4.2 Applicable or Relevant and Appropriate Requirements

TBC
To Be Considered
(Requirements)

IAC
Illinois Administrative
Code

Section 300.415(i) of the NCP states that fund-financed removal actions under CERCLA Section 104 shall, to the extent practicable considering the exigencies of the situation, attain ARARs under federal or state environmental laws. Other advisories, criteria, or guidance may be considered for a particular site, and are referred to as To Be Considered (TBC) requirements.

Under CERCLA, as amended by SARA, a requirement may be either "applicable" or "relevant and appropriate" to a specific removal action, but not both. Definitions of the components of ARARs are listed below:

- **Applicable Requirements** mean those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site.
- **Relevant and Appropriate Requirements** mean those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.

4.2.1 Applicable or Relevant and Appropriate Requirements/To be Considered Requirements for the JW Site

A listing of the potential ARARs for the removal action at the JW site is provided in Appendix J. The primary ARARs and other criteria "to be considered" that were used to evaluate removal action alternatives for the JW site are discussed in this section.

Part 620—Groundwater Quality. Title 35 of the Illinois Administrative Code (IAC), Part 620, entitled Groundwater Quality, prescribes various aspects of groundwater quality in Illinois. Part 620 includes methods of classifying groundwater (Class I through Class IV), nondegradation provisions, standards for the quality of groundwater, and procedures and protocols for

4. Removal Action Scope and Objectives

the management and protection of groundwater.

GMZ
Groundwater
Management Zone

SDWA
Safe Drinking Water Act

MCLGs
Maximum Contaminant
Level Goals

BAT
Best Available
Technology

All of the groundwaters of the state of Illinois are designated as one of the following four classes of groundwater, or as a Groundwater Management Zone (GMZ):

- Class I: Potable Resource Groundwater;
- Class II: General Resource Groundwater;
- Class III: Special Resource Groundwater; and
- Class IV: Other Groundwater.

A GMZ may be established within any class of groundwater as a three-dimensional region containing groundwater being managed to mitigate impairment caused by the release of contaminants from a site. The two methods for establishing a GMZ are:

- Approval by the IEPA under an existing corrective action process.
- Confirmation on a form prescribed by the Agency that adequate corrective action is being undertaken in a timely and appropriate manner.

In any GMZ, the goal is active remediation of the groundwater to the level of the standards applicable to that class of groundwater. These standards are presented in Subpart D of Part 620, which is entitled Groundwater Quality Standards. Subpart D provides groundwater quality standards for Class I through Class IV groundwaters, and also a method for the implementation of Alternative Groundwater Quality Standards for sites at which a GMZ has been established. The groundwater quality standards for Class I groundwater are the same values as the TACO Tier 1 “look-up” table values.

Safe Drinking Water Act. The Safe Drinking Water (SDWA) of 1974 establishes a federal program to monitor and increase the safety of all commercially and publicly supplied drinking water supplies. Congress amended the SDWA in 1986, mandating changes in nationwide safeguards for drinking water and establishing new federal enforcement responsibility on the part of EPA. The 1986 amendments required EPA to establish MCLs, Maximum Contaminant Level Goals (MCLGs), and Best Available Technology (BAT) treatment techniques for organic, inorganic, radioactive, and microbial contaminants in drinking water.

Because the SDWA applies to commercial and public water supplies, it is not directly applicable to the removal action at the JW site. It is relevant and appropriate, however, in that the MCLs set by the act are commonly used as groundwater cleanup objectives (CUOs) for environmental remediation projects.

CUOs
cleanup objectives

RCRA
Resource Conservation
and Recovery Act

TSD
treatment, storage, and
disposal

UIC
Underground Injection
Control

4. Removal Action Scope and Objectives

Resource Conservation and Recovery Act. The Resource Conservation and Recovery Act (RCRA) was enacted in 1976 as an amendment to the Solid Waste Disposal Act to ensure the proper management of solid wastes. The broad goals set by RCRA are:

- to protect human health and the environment from the hazards posed by waste disposal;
- to conserve energy and natural resources through waste recycling and recovery;
- to reduce or eliminate the amount of waste generated, including hazardous waste, as expeditiously as possible; and
- to ensure that wastes are managed in a manner that is protective of human health and the environment.

RCRA consists of three distinct yet interrelated programs in order to achieve these goals. RCRA Subtitle C, the hazardous waste program, establishes a management system that regulates hazardous waste from the time it is generated until its ultimate disposal. The system establishes requirements for hazardous waste identification; generators; transporters; treatment, storage, and disposal (TSD) facilities; hazardous waste recycling; land disposal restrictions; combustion; permitting; corrective action; enforcement; and state authorization. IEPA has determined that approximately 300 cubic yards of soil directly underneath the drip tracks contains waste materials from the wood-treating operations at the JW site and will be considered an F-listed hazardous waste (F032 and F034). The management of this material (removal and off-site incineration at an appropriately permitted facility) will be conducted in accordance with RCRA Subtitle C.

Groundwater ReInjection. Several of the removal action alternatives presented in Section 5 of this EE/CA report include the reInjection of extracted groundwater into the subsurface. In Illinois, EPA Region 5 classifies and regulates injection wells. EPA's Underground Injection Control (UIC) branch has five classes of injection wells. An injection well that is part of a groundwater treatment system would be a Class I injection well. EPA has delegated primary regulatory authority of the UIC program to the State of Illinois because Illinois has demonstrated the ability to implement a UIC program that meets the EPA requirements found in 40 CFR Part 145. If the design document prepared for the removal action at the JW site includes groundwater reInjection, approval from IEPA's UIC division would need to be obtained.

4. Removal Action Scope and Objectives

Air Pollution Control. Depending on the final removal action selected for implementation at the JW site, an air permit(s) may be required. During the removal action design phase, the IEPA Bureau of Air, Division of Air Pollution Control, Permits Section, should be contacted to discuss the potential air impacts of this project. Based on the outcome of these discussions, the design engineer may need to obtain any required air permits.

Demolition. Prior to the demolition of the on-site buildings, razing permits would need to be obtained from the Granite City building inspector's office. One permit would be required for each of the structures to be demolished. The current cost of a razing permit is \$10. Also, the demolition contractor would need to obtain a Granite City business license at a cost of \$35. According to the building inspector's office, the necessary permits and licenses could be obtained in one day.

Asbestos. Per 40 CFR Part 61 (the National Emission Standard for Asbestos), the owner of a structure planned for demolition must thoroughly inspect the structure for the presence of ACM. This inspection was conducted by E & E as part of the EE/CA support sampling. ACM is categorized into three categories:

- **Category I nonfriable ACM**—Includes asbestos-containing packings, gaskets, floor covering, and asphalt roofing products containing more than 1% asbestos. The floor tiles in the office building are an example of Category I nonfriable ACM;
- **Category II nonfriable ACM**—Includes any material, excluding Category I nonfriable ACM, containing more than 1% asbestos that, when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure. The panels on the walls of the Transite building are examples of Category II nonfriable ACM; and
- **Friable ACM**—Includes any material containing more than 1% asbestos that, when dry, can be crumbled, pulverized, or reduced to powder by hand pressure. Pipe wrap present in the boiler building is an example of friable ACM.

RACM
regulated asbestos-
containing material

TACO
*Tiered Approach to
Corrective Action
Objectives*

The asbestos standard for demolition is presented in 40 CFR Part 61.145. The standard consists of three paragraphs: (a) Applicability, (b) Notification requirements, and (c) Procedures for asbestos emission control. Based upon the amount of regulated asbestos-containing material (RACM) present in a demolition project, paragraph (a) differentiates between those projects that must comply with both paragraphs (b) and (c), and those projects that need only comply with certain notification requirements in paragraph (b).

4. Removal Action Scope and Objectives

RACM is defined as:

- Friable ACM;
- Category I nonfriable ACM that has become friable, or that will be or has been subjected to sanding, grinding, cutting, or abrading;
- Category II nonfriable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder by the forces expected to act on the material in the course of demolition.

An owner of a demolition project must comply with both paragraphs (b) and (c) if the combined amount of RACM is at least 260 linear feet on pipes or at least 160 square feet on other structural components. An owner of a demolition project must comply only with certain notification requirements of paragraph (b) if the combined amount of RACM is less than 260 linear feet on pipes and less than 160 square feet on other structural components.

For the JW site, there are less than 260 linear feet of RACM on pipes, but there are more than 160 square feet of RACM on other structural components. Therefore, the demolition of the site buildings would need to comply with both paragraphs (b) and (c).

TACO. Title 35 IAC, Part 742, entitled *Tiered Approach to Corrective Action Objectives* (or TACO), is the IEPA's method for developing remediation objectives (hereafter referred to as CUOs) for contaminated soil and groundwater in Illinois. These CUOs protect human health and take into account site conditions and land use. CUOs generated by TACO are risk-based and site-specific (IPCB 1997). TACO is considered a TBC requirement rather than an ARAR. According to IEPA, TACO cannot be an ARAR on Superfund sites since it is not legally enforceable. TACO, however, can be used as a screening tool, and Tier 1 cleanup values could be used as proposed cleanup goals for soil or water as part of a risk assessment. There are three tiers of CUOs in TACO.

A Tier 1 evaluation compares the concentration of contaminants detected at a site to the corresponding CUOs contained in "look-up" tables. These CUOs are based on simple, conservative models. To complete a Tier 1 evaluation, the following must be known:

- The extent and concentrations of contaminants of concern for both soil and groundwater;
- The groundwater classification as defined in 35 IAC Part 620

4. Removal Action Scope and Objectives

(a description of Part 620 is provided later in this section); and

- The intended land use at the site (either residential or industrial/commercial).

If CUOs are based on an industrial/commercial land use, then an institutional control prohibiting the property from residential use would be imposed by IEPA (IEPA 1997).

SSL
Soil Screening Level

RBCA
Risk-Based Corrective
Action

A Tier 2 evaluation uses risk-based equations from Soil Screening Level (SSL) and Risk-Based Corrective Action (RBCA) approaches. In addition to the information that is required for a Tier 1 evaluation, the following information is considered:

- The physical and chemical properties of the contaminants;
- Site-specific soil and groundwater parameters (e.g., soil type, soil organic carbon content, hydraulic conductivity); and
- The application of institutional controls and engineered barriers.

The additional Tier 2 information can allow for the calculation of less stringent but equivalently protective CUOs as Tier 1.

A Tier 3 evaluation allows alternative parameters and factors, not available under a Tier 1 evaluation or a Tier 2 evaluation, to be considered when developing CUOs. Situations that can be considered for a Tier 3 evaluation include, but are not limited to:

- Modification of the input parameters used in risk assessment models not allowed under Tier 2;
- Use of different risk assessment models from those used in Tier 2;
- Use of additional site data to improve or confirm predictions of exposed receptors;
- Analysis of site-specific risks using formal risk assessment, probabilistic data analysis, and sophisticated fate and transport models;
- The impracticality of further remediation;
- Incomplete human exposure pathway(s) not excluded under 35 IAC Part 742, Subpart C;
- Use of toxicological-specific information not available from

4. Removal Action Scope and Objectives

the sources listed in Tier 2; and

- Land uses that are substantially different from the assumed residential or industrial/commercial property uses of a site.

The SRE performed for the JW site and presented in Section 3 is the equivalent of a TACO Tier 3 evaluation.

RAOs Removal Action Objectives

4.3 Removal Action Objectives

Removal Action Objectives (RAOs) are medium-specific goals for protecting human health and the environment. The RAOs for the JW site were established under the broad guideline of being protective of human health and the environment, while remaining within statutory limits and attaining ARARs to the extent practicable. The RAOs were developed to reduce the potential for exposure through specific removal actions (i.e., institutional controls, containment, removal, and/or treatment). During the development of the RAOs, ARARs and contaminant concentrations are evaluated to establish risk-based CUOs and to determine the scope of the removal action(s) necessary to meet the objectives. The CUOs proposed for the JW site are presented in Section 4.3.1.

Based on the identified ARARs and TBC requirements, and the need to reduce the potential threat to human health and the environment, the following general RAOs were developed for the JW site:

- Prevent current nearby residents and potential future site workers from contacting, ingesting, or inhaling on-site soil and waste materials containing COPCs that exceed the calculated risk-based CUOs;
- Prevent the continued release of contaminants to groundwater;
- Initiate long-term groundwater restoration;
- Abate RACM present in the on-site buildings;
- Remove listed hazardous waste from the site for treatment and disposal at an appropriately licensed facility; and
- To the extent practical, pump NAPL from the subsurface in the vicinity of the 22nd Street lagoon, and treat collected groundwater.

4.3.1 Cleanup Objectives

Using the SRE as a basis, CUOs were calculated for the 10^{-6} , 10^{-5} , and 10^{-4} risk levels for both soil and groundwater. Based on a

4. Removal Action Scope and Objectives

review of treatment technologies for wood treating sites, treatment efficiencies ranging from 74% to 99% can be achieved. Utilizing the site data, and based upon review of technology literature sources, it is uncertain as to whether existing treatment technologies can obtain a 10^{-6} risk level for soils. However, a 10^{-5} risk level likely can be achieved. Therefore, IEPA has directed E & E to use the 10^{-5} risk level CUOs for soils and the 10^{-6} risk level CUOs for groundwater, to calculate volumes of materials above CUOs and to conduct the evaluation of removal action alternatives.

The proposed CUOs for the removal action at the JW site are presented in Table 4-1. With two exceptions, the CUOs presented in Table 4-1 are protective of human health to the corresponding 10^{-5} and 10^{-6} risk levels for soil and groundwater, respectively. For arsenic in groundwater, a 10^{-6} risk level CUO of 0.2 $\mu\text{g/L}$ was calculated. However, because this value is less than the MCL for arsenic, 50 $\mu\text{g/L}$, the MCL has been chosen for the CUO. It should also be noted that there is no current groundwater use at the site. Additionally, the risk assessment concluded that exposure to contaminants through the use of site groundwater as a drinking water source is unlikely, since there is a public water system that serves the area. Therefore, the use of the MCL as the CUO for arsenic is supported.

ATSDR
Agency for Toxic
Substances and Disease
Registry

RODs
Records of Decision

For dioxin in soil, a 10^{-5} risk level CUO of 0.2 $\mu\text{g/kg}$ was calculated. However, based on a review of the Agency for Toxic Substances and Disease Registry (ATSDR) document titled *Dioxin and Dioxin-Like Compounds in Soil, Part I: ATSDR Interim Policy Guidelines*, a CUO of 1 $\mu\text{g/kg}$ is recommended by ATSDR for dioxin (De Rosa 1997). Based on a review of EPA Records of Decision (RODs) for several dioxin sites in the St. Louis metropolitan area, it is apparent that a CUO for dioxin of 1 $\mu\text{g/kg}$ is commonly used. Therefore, it is proposed that a CUO of 1 $\mu\text{g/kg}$ for TCDD-TEF be used at the JW site.

4.4 Removal Action Scope

The proposed scope of the removal action consists of those areas of the site containing RCRA hazardous waste and media with concentrations of COPCs above the risk-based CUOs. Media included in the scope of this EE/CA are soils and wastes, NAPLs, and groundwater. In addition, to facilitate the implementation of a removal action to address site soils and wastes, NAPLs, and groundwater, the site's buildings, silos, concrete foundations and slabs, and the miscellaneous waste and debris items are included in the scope. Miscellaneous items include the two USTs, two ASTs, the oil/water separator, various sumps and pits, the collapsed pole barn, abandoned tram tracks, and debris piles. Table 4-2 presents the areas and estimated volumes of materials included in this

4. Removal Action Scope and Objectives

EE/CA.

4.4.1 Soils and Wastes

Because it is planned that site soils and non-RCRA hazardous wastes contained in the various on-site disposal areas will be managed in the same manner, these materials have been grouped together. It is estimated that a total of 55,100 in-place cubic yards of soils and wastes are present on site which contain COPCs exceeding the proposed CUOs.

Surface Soils. A total of 23 surface soil (i.e., 0- to 6-inch interval) samples contained at least one COPC above its CUO. For conservative volume calculation purposes, it was assumed that the top 1 foot of soil across the entire site is contaminated with COPCs exceeding CUOs. TCLP analysis indicates that the soil does not exhibit RCRA hazardous waste characteristics.

RCRA Hazardous Waste. Several shallow soil borings performed during the EE/CA indicate the presence of tar and heavy staining adjacent to tram tracks. In these areas, the visual thickness of the tar and staining did not exceed 18 inches. In order to be conservative, an additional 1-foot thickness of soil is estimated for removal over approximately one-half of the site area. This 1-foot surface soil removal across the entire site plus the removal of an additional 1-foot thickness over approximately half the site equates to an in-place volume of approximately 32,759 cubic yards.

At the direction of IEPA, approximately 300 cubic yards of soil directly beneath the drip tracks that contains waste material related to the wood-treating operations at the site will be considered an F-listed hazardous waste (F032 and F034). The soil is visibly contaminated in the aforementioned area; consequently, initial removal efforts will be focused on visual identification of contamination. Confirmation sampling will be conducted in the excavation areas to ensure that RCRA-listed hazardous wastes are not left on site. The results of TCLP analysis of surface soil, subsurface soil, and sediment samples (outside of the 300 cubic yards of soil discussed above) indicate that soils and sediment at the site are not characteristic hazardous waste as defined by RCRA.

Subsurface Soils and Wastes. At least one subsurface sample from the following soil borings contained at least one COPC above its CUO: SB26, SB32, SB33, and SB35. Figure 4-1 presents those areas of the JW site with subsurface soil/waste contamination exceeding CUOs and the associated volumes. TCLP analysis indicates that the soil does not exhibit RCRA hazardous waste characteristics. The volumes shown on Figure 4-1 were estimated in the following ways. To estimate the volume of wastes present in

4. Removal Action Scope and Objectives

the various disposal areas (i.e., Area H, the 22nd Street lagoon, and waste beneath the concrete basin), the boundaries of the disposal areas were inferred using field observations and historical aerial photographs (see Appendix A). The vertical extent of the wastes present in the disposal areas was assumed to extend to the water table at 17 feet BGS. It should be noted that special considerations may be necessary with removal of soils/wastes from the 22nd Street lagoon in that coordination with the railroad will be needed and sloping of excavation walls or the use of sheet piling may be required to ensure the rail spur stability.

The waste boundaries for the Jennite Pit area were also estimated using field observations and aerial photographs, and the vertical extent of wastes present was assumed to extend to the water table at 16 feet BGS. For other areas of subsurface soil contamination across the site, the extent of contamination was assumed to encompass 2,500 square feet (50 feet by 50 feet) centered on the contaminated soil boring in question, to a depth of 8 feet BGS. The total volume of subsurface soil/waste exceeding CUOs is approximately 22,383 cubic yards.

Of interest is that the subsurface soil samples collected within Area H and the Jennite pit did not exceed CUOs. However, based on the presence of groundwater contamination exceeding CUOs in monitoring well MW2S located on the southwestern edge of Area H, it is assumed that the one soil boring placed in this area (SB31) missed the source of this groundwater contamination. In addition, 1991 IEPA borings SB1 and SB2 located in Area H indicated visibly contaminated soils throughout the entire unsaturated zone. Therefore, as shown on Figure 4-1, subsurface soils and wastes in Area H have been included in the proposed removal action scope.

Similarly, it is assumed that waste materials are present in the Jennite pit, and the one soil boring placed in this area (SB34), which showed only limited contamination, missed the waste. Although no samples were collected during IEPA's 1991 field effort, the appearance of the groundwater and the contamination detected by E & E in monitoring well MW9S suggest that the entire unsaturated zone within the Jennite Pit area would require remediation. Therefore, subsurface soils and wastes beneath the Jennite Pit area have been included in the proposed removal action scope.

4.4.2 Non-Aqueous-Phase Liquids

NAPLs are present in the vicinity of the 22nd Street lagoon. During EE/CA support sampling, approximately 1 inch of NAPL was observed in the bottom of monitoring well MW5S, and NAPLs were observed to be present from the top of the aquifer (18 feet BGS) to the bedrock surface (115 feet BGS) during the drilling

4. Removal Action Scope and Objectives

of monitoring well boring MW5D. E & E observed an increase of NAPL with depth, indicating the likelihood of NAPL pooling on the bedrock surface.

DNAPLs

dense non-aqueous-phase liquids

LNAPLs

light non-aqueous-phase liquids

NAPLs are divided into two categories: dense non-aqueous-phase liquids (DNAPLs) and light non-aqueous-phase liquids (LNAPLs). DNAPLs have a specific gravity greater than 1.0; LNAPLs have a specific gravity less than 1.0. Because of the composition of the wood preservatives used at the JW site, both LNAPLs and DNAPLs are likely present in the 22nd Street lagoon area (EPA 1995b).

Calculating an accurate volume of NAPL present in the 22nd Street lagoon area is difficult. It is known that NAPL is present in the vicinity of wells MW5S and MW5D, and it is likely that NAPL is present beneath the entire 22nd Street lagoon. It is known that NAPL is not present in any of the wells of the MW6 and MW9 well nests, located approximately 260 feet and 570 feet, respectively, downgradient from the 22nd Street lagoon area. In addition, NAPL was not observed in Geoprobe groundwater samples GP08S, GP11S, GP38S, or GP38M, located within 200 feet of the 22nd Street lagoon area.

For volume determination purposes, the estimated areal extent of the NAPL plume is shown on Figure 4-2. This area encompasses approximately 23,400 square feet. With a saturated thickness of approximately 97 feet, the total subsurface saturated volume where NAPL is estimated to be present is approximately 17 million gallons. Assuming an effective porosity of 30%, the volume of groundwater in this total subsurface volume is 5.1 million gallons. Assuming that, of this groundwater volume, 1% is NAPL, there are roughly 51,000 gallons of NAPL present. A NAPL percentage of 1% was chosen based on the amount of NAPL observed in well MW5S (1 inch NAPL, 91 inches groundwater). In reality, the actual volume of NAPL could vary significantly from this estimate. However, for cost estimating purposes, a NAPL volume of 51,000 gallons was assumed.

4.4.3 Groundwater

Based on the EE/CA support sampling analytical data, there are five areas on site where groundwater contamination was identified. Figures 4-3 through 4-6 present an estimation of the extent of these plumes.

The most significant plume of groundwater contamination originates at the 22nd Street lagoon and flows downgradient (south-southwest). It is referred to as the 22nd Street lagoon plume in this report. The waste present beneath the concrete basin, the former process tanks in the creosote area that are now removed,

4. Removal Action Scope and Objectives

and the east UST are all potentially additional source areas for this plume. It is within this plume that the only NAPL observed on site was found. This plume is characterized by benzene, PAH, manganese, and PCP concentrations above the proposed CUOs.

The secondmost significant plume originates in the PCP process area, and is referred to as the PCP process area plume in this report. In the shallow zone of the unconsolidated aquifer, PCP concentrations significantly above the CUO were detected in wells MW8S and old 8S. The shallow plume appears to flow west off the site (see Figure 4-5). However, based on clean sampling results in Geoprobe groundwater samples GP41S and GP42S, this plume is confined to a limited area adjacent to the western site boundary. In the intermediate aquifer, the plume flows primarily to the south and is characterized by the presence of both PCP and PAHs (see Figures 4-4 and 4-6).

A third plume originates in Area H, and is characterized by relatively low-level PCP and PAH contamination. The extent of this plume in the shallow and intermediate aquifers is shown on Figures 4-3, 4-5, and 4-6.

A fourth area of groundwater contamination is present in the well nest MW9 area located downgradient of the Jennite pit. From Figure 4-3, it appears that the contamination present in shallow well MW9S is solely a result of waste in the Jennite pit. The source of contamination present in the intermediate well MW9M is less conclusive. From Figure 4-4, the contamination present in MW9M appears to represent the leading edge of the 22nd Street lagoon plume. However, based on the downward gradient present between monitoring wells MW9S and MW9M, and the direction of groundwater flow (refer to Figures 2-7 and 2-8), the contamination present in MW9M may represent a vertical migration from the Jennite pit.

A fifth area of groundwater contamination is located just south of the silos. A Geoprobe groundwater sample (GP16S) collected in this area contained PCP at a concentration greater than 100 ppb based on immunoassay field screening. This sample was non-detect for the PAHs, however. The source of this contamination is unknown, but may be a result of the debris pile in this area. This area of contamination is suspect, however, because it is based on a single data point. Limited additional investigation may be warranted in this area to confirm the presence of a plume. This additional work could be conducted as a predesign activity.

Tables 4-3, 4-4, and 4-5 compare the maximum detected groundwater contamination concentrations to CUOs for the shallow, intermediate, and deep zones of the aquifer, respectively.

4. Removal Action Scope and Objectives

R & M
Rubinos & Mesia
Engineers, Inc.

4.4.4 Buildings

There are five buildings and two silos on site. The buildings are referred to as the office building, the white building, the creosote treatment building (also called the green building), the boiler building, and the transite building. E & E subcontracted Rubinos & Mesia Engineers, Inc. (R & M), to perform a structural assessment of the site buildings. With the exception of the office building, R & M's report recommended that the site buildings be demolished. The report is included in Appendix E. Table 4-2 presents an estimate of the volume of RACM present in the buildings, and the volume of concrete foundation and slab material associated with the structures.

4.4.5 Miscellaneous Items

This group consists of the following items present on the site: two empty USTs, two ASTs that contain oil, an oil/water separator that contains sheened rainwater, liquids and sediments present within the concrete basin, the collapsed pole barn, several sumps and pits that contain oily waste, scattered debris piles, and steel tram rail. To facilitate implementation of a removal action at the site and future site redevelopment, it is recommended that these items be removed from the site and recycled, reused, or disposed of, as appropriate. Associated areas and volumes for these items are presented in Table 4-2.

PRSCs
post-removal site
controls

4.5 Removal Action Schedule

The final removal action schedule will be determined by IEPA. Generally, the estimated time frames to implement the individual removal action alternatives for site soils and wastes range from 1 to 6 years, NAPL removal action alternatives range from 3 to 4 years, and groundwater removal action alternatives range from 1 to 2 years for construction, and up to 30 years for post-removal site controls (PRSCs). PRSCs consist of system operation and maintenance, and groundwater monitoring. Each of the removal action alternatives is described in Section 5.

Based upon the removal action scope described above, a waiver of the 12-month statutory time limit for the removal action would be required. Implementation of the "consistency" waiver may increase the removal action frame to allow a removal action that is otherwise appropriate and consistent with the final response action to be taken.

These time frames do not include a public comment period on the final EE/CA, nor do they include time required for engineering design. As in all schedules for environmental construction, the weather can impact the progress of work. The time frames presented, however, do take into account periods of normally inclement weather and associated shutdown periods.

4. Removal Action Scope and Objectives

<p align="center">Table 4-1</p> <p align="center">PROPOSED CLEANUP OBJECTIVES</p> <p align="center">JENNISON-WRIGHT SITE</p> <p align="center">GRANITE CITY, ILLINOIS</p>		
Soil COPC	Proposed CUO (µg/kg)	IEPA TACO Tier 1 (µg/kg)
Benzene	3,000 ^a	2,100
Benzo(a)anthracene	14,000 ^b	170,000
Benzo(a)pyrene	2,000 ^c	17,000
Benzo(b)fluoranthene	22,000 ^c	170,000
Benzo(k)fluoranthene	32,000 ^b	1,700,000
Naphthalene	27,000 ^a	8,200,000
Carbazole	954,000 ^c	None
Dibenzo(a,h)anthracene	2,000 ^c	17,000
Indeno(1,2,3-cd)pyrene	11,000 ^b	170,000
PCP	51,000 ^b	520,000
TCDD-TEF	1.0	None
Groundwater COPC	Proposed CUO (µg/L)	IEPA TACO Tier 1 (µg/L)
Arsenic	50	50
Benzene	10	5.0
Benzo(a)anthracene	0.13	0.13
Benzo(b)fluoranthene	0.18	0.18
Benzo(k)fluoranthene	0.4	0.17
Chrysene	4	1.5
PCP	1.0	1.0
alpha-BHC	0.03	0.03
Manganese	200	None
Naphthalene	400	25
2,4-Dimethylphenol	200	140
2-Methylphenol	500	350

^a CUO is based on the construction worker scenario.

^b CUO is based on the estimated soil saturation concentration.

^c CUO is based on the permanent site worker scenario.

Note: The proposed CUOs were calculated using the results of the Streamlined Risk Evaluation (SRE) as a basis. The proposed soil CUOs represent the 10⁻⁵ risk level for carcinogens, or a Hazard Quotient of 1 for noncarcinogens, with the exception of dioxin (TCDD-TEF) in soil, as described in the text. The proposed groundwater CUOs represent the 10⁻⁶ level for carcinogens or a Hazard Quotient of 1 for noncarcinogens, or the MCL. The IEPA TACO Tier 1 values are provided for comparison. TACO Tier 1 values represent the 10⁻⁶ risk level for carcinogens, and a Hazard Quotient of 1 for noncarcinogens. For soil, the more conservative (i.e., lower) of the ingestion or inhalation values for industrial/commercial properties, construction worker scenario, are shown. For groundwater, the TACO Tier 1 figures are equivalent to the Class I groundwater quality standards.

Table 4-1 (Cont.)

Key:

COPC	= Chemical of potential concern.
CUO	= Cleanup objective.
IEPA	= Illinois Environmental Protection Agency.
µg/kg	= Micrograms per kilogram.
µg/L	= Micrograms per liter.
PCP	= Pentachlorophenol.
TACO	= <i>Tiered Approach to Corrective Action Objectives</i> .
TCDD-TEF	= 2,3,7,8-Tetrachlorodibenzo-p-dioxin Toxicity Equivalence Factor.

Table 4-2

**AREA AND REMOVAL ACTION VOLUME ESTIMATES
JENNISON-WRIGHT SITE
GRANITE CITY, ILLINOIS**

Area/Item	Volume
Soils and Wastes and NAPLs	
Surface Soils	32,759 cubic yards
Subsurface Soils and Wastes	22,383 cubic yards
F032 and F034 waste	300 cubic yards
NAPLs	51,000 gallons
RACM	
White Building Boilerjacket	85 square feet
White Building Pipe Runs	101 linear feet
Boiler Building Pipe Runs	80 linear feet
Transite Building Panels	7,000 square feet
Concrete Foundation and Slabs	
Boiler Building	124 cubic yards
Green Building	65 cubic yards
Transite Building	142 cubic yards
Concrete Basin (assume 4-foot side walls)	269 cubic yards
Office Building	65 cubic yards
White Building	100 cubic yards
Oval Sump Slab	84 cubic yards
Miscellaneous Slab 1	324 cubic yards
Miscellaneous Slab 2	156 cubic yards
Miscellaneous Slab 3	215 cubic yards
Miscellaneous Slab 4	148 cubic yards
Miscellaneous Slab 5	37 cubic yards
Miscellaneous Slab 6	44 cubic yards
Equipment Slabs (5)	27 cubic yards
Miscellaneous Items	
AST Oil and Sludge	7,560 gallons
Oil/Water Separator Liquid	2,842 gallons
Concrete Basin Liquid	26,053 gallons
Miscellaneous Items (Cont.)	

<p style="text-align: center;">Table 4-2</p> <p style="text-align: center;">AREA AND REMOVAL ACTION VOLUME ESTIMATES</p> <p style="text-align: center;">JENNISON-WRIGHT SITE</p> <p style="text-align: center;">GRANITE CITY, ILLINOIS</p>	
Area/Item	Volume
Concrete Basin Sludge	8,684 gallons
Total Sump and Pit Liquid	5,931 gallons
Debris Piles	4,133 cubic yards
Tram Rail	5,148 linear feet

Key:

AST = Aboveground storage tank.
 NAPL = Non-aqueous-phase liquid.
 RACM = Regulated asbestos-containing material.

<p align="center">Table 4-3</p> <p align="center">COMPARISON OF GROUNDWATER CONTAMINANT CONCENTRATIONS TO CLEANUP OBJECTIVES—SHALLOW ZONE ENGINEERING EVALUATION / COST ANALYSIS JENNISON-WRIGHT SITE GRANITE CITY, ILLINOIS</p>			
COPC	Groundwater		
	Maximum Concentration (µg/L)	Cleanup Objective (µg/L)	Monitoring Well with Maximum Concentration
Arsenic	64 J	50	MW8S
Benzene	930	10	MW5S
Benzo(a)anthracene	ND	0.4	NA
Benzo(b)fluoranthene	ND	0.4	NA
Chrysene	ND	40	NA
Benzo(k)fluoranthene	ND	4.0	NA
PCP	88,000 J	2.4	MW8S
alpha-BHC	0.26 J	0.05	MW8S
Manganese	5,810	2,000	MW5S
Naphthalene	21,000	4,000	MW5S
2,4-Dimethylphenol	15,000	2,000	MW5S
2-Methylphenol	21,000	5,000	MW5S

Key:

COPC = Chemical of potential concern.
 J = Estimated value.
 NA = Not applicable.
 ND = Not detected (in any shallow well).
 PCP = Pentachlorophenol.
 µg/L = Micrograms per liter.

<p align="center">Table 4-4</p> <p align="center">COMPARISON OF GROUNDWATER CONTAMINANT CONCENTRATIONS TO CLEANUP OBJECTIVES—INTERMEDIATE ZONE ENGINEERING EVALUATION / COST ANALYSIS JENNISON-WRIGHT SITE GRANITE CITY, ILLINOIS</p>			
COPC	Groundwater		
	Maximum Concentration (µg/L)	Cleanup Objective (µg/L)	Monitoring Well with Maximum Concentration
Arsenic	3.2 J	50	MW9M
Benzene	75	10	MW6M
Benzo(a)anthracene	ND	0.4	NA
Benzo(b)fluoranthene	ND	0.4	NA
Chrysene	ND	40	NA
Benzo(k)fluoranthene	ND	40	NA
PCP	ND	2.4	NA
alpha-BHC	ND	0.05	NA
Manganese	893	2,000	MW11M
Naphthalene	ND	4,000	NA
2,4-Dimethylphenol	ND	2,000	NA
2-Methylphenol	ND	5,000	NA

Key:

COPC = Chemical of potential concern.
 J = Estimated value.
 NA = Not applicable.
 ND = Not detected (in any intermediate well).
 µg/L = Micrograms per liter.
 PCP = Pentachlorophenol.

<p align="center">Table 4-5</p> <p align="center">COMPARISON OF GROUNDWATER CONTAMINANT CONCENTRATIONS TO CLEANUP OBJECTIVES—DEEP ZONE ENGINEERING EVALUATION / COST ANALYSIS JENNISON-WRIGHT SITE GRANITE CITY, ILLINOIS</p>			
COPC	Groundwater		
	Maximum Concentration (µg/L)	Cleanup Objective (µg/L)	Monitoring Well with Maximum Concentration
Arsenic	2.8	50	MW8D
Benzene	ND	10	NA
Benzo(a)anthracene	5	0.4	MW5D
Benzo(b)fluoranthene	2	0.4	MW5D
Chrysene	5J	40	MW5D
Benzo(k)fluoranthene	2J	4.0	MW5D
PCP	13 J	2.4	MW5D
alpha-BHC	ND	0.05	NA
Manganese	403	2,000	MW8D
Naphthalene	920	4,000	MW5D
2,4-Dimethylphenol	ND	2,000	NA
2-Methylphenol	ND	5,000	NA

Key:

- COPC = Chemical of potential concern.
- J = Estimated value.
- NA = Not applicable.
- ND = Not detected (in any deep well).
- µg/L = Micrograms per liter.
- PCP = Pentachlorophenol.

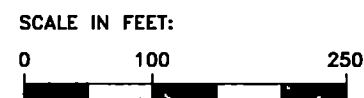
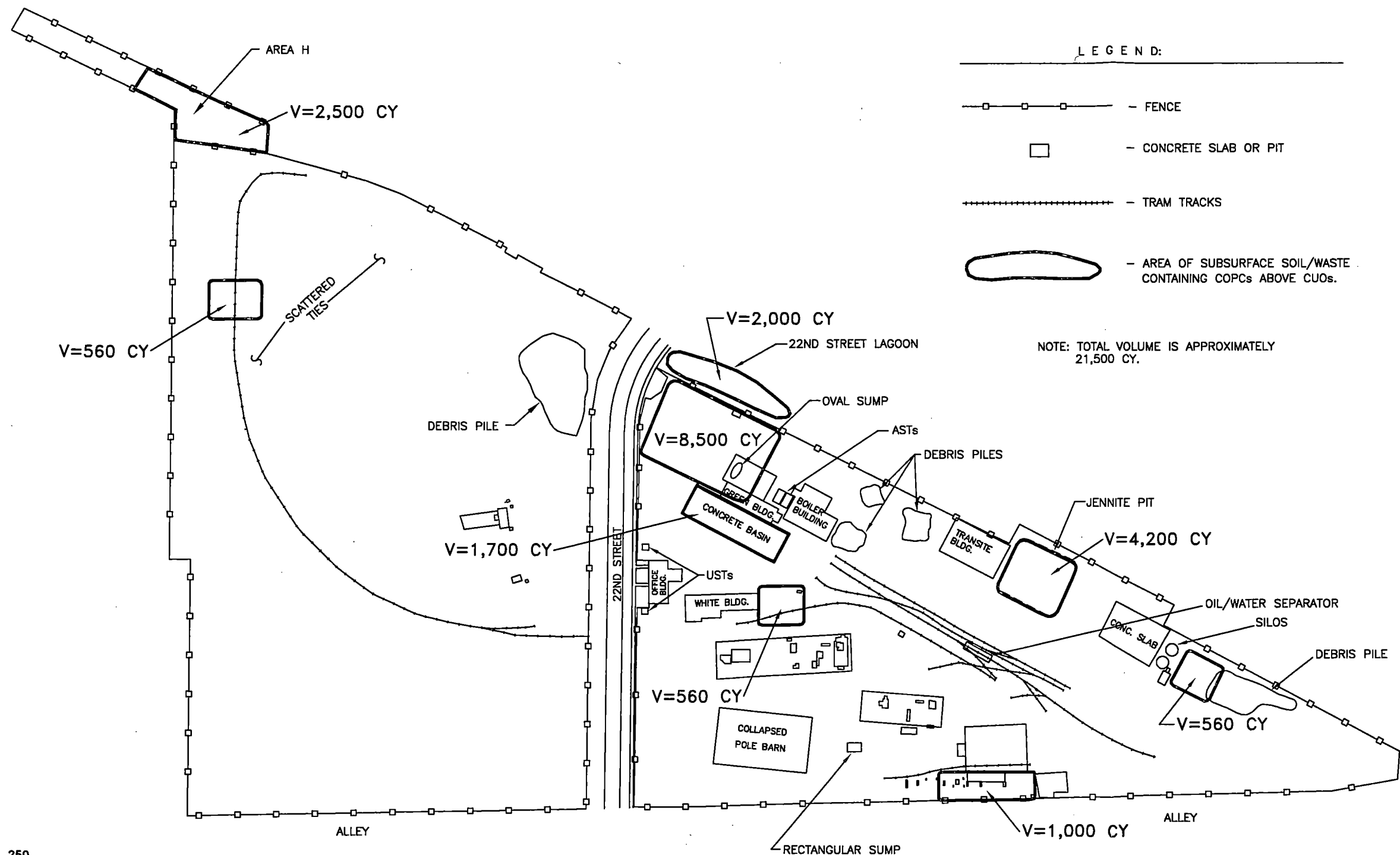


Figure 4-1
SUBSURFACE SOIL/WASTE
CONTAMINATION ABOVE CLEANUP
OBJECTIVES
JENNISON-WRIGHT SITE
GRANITE CITY, ILLINOIS

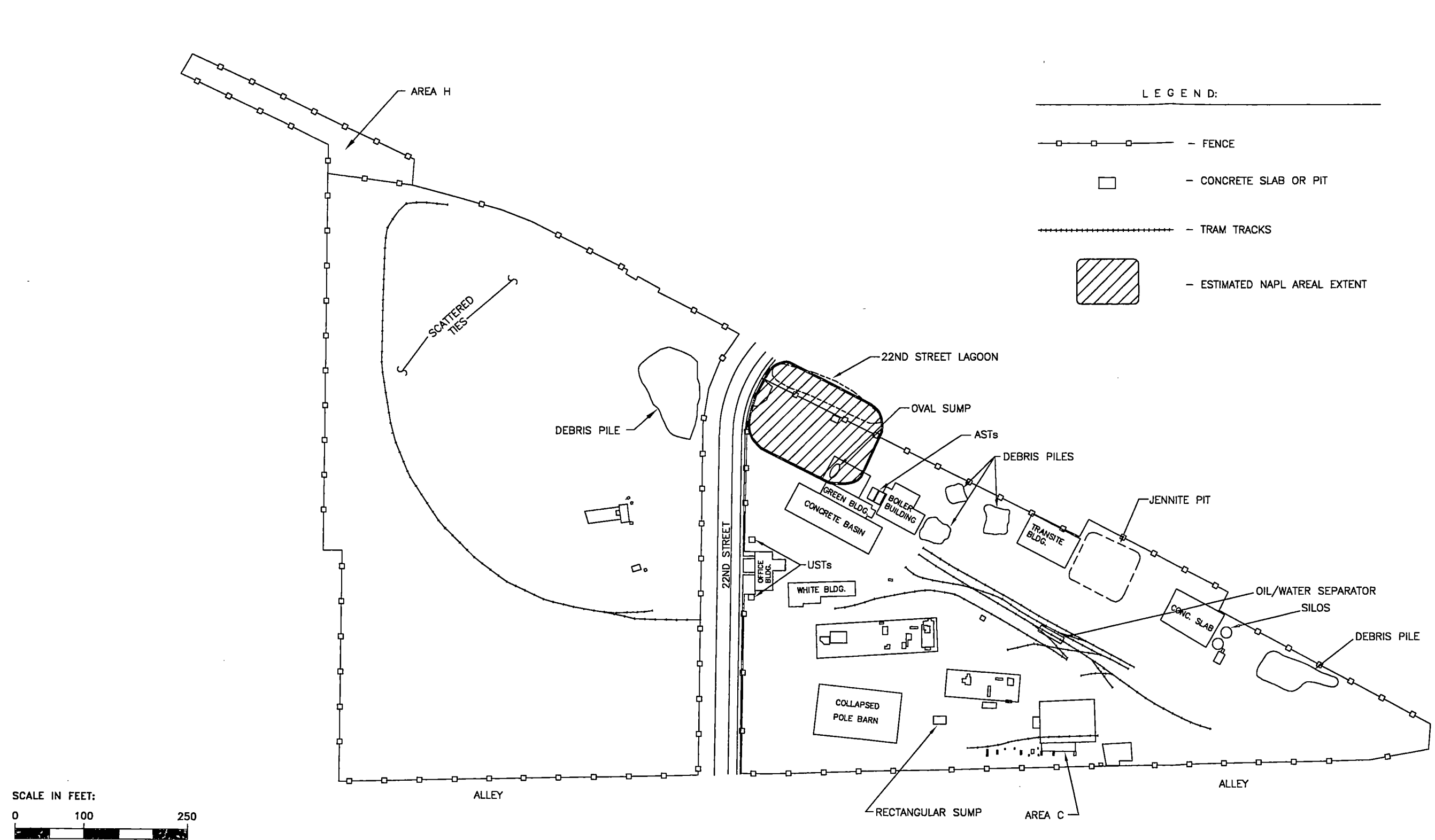


Figure 4-2 ESTIMATED AREAL EXTENT OF NAPL
JENNISON-WRIGHT SITE
GRANITE CITY, ILLINOIS



LEGEND:

- FENCE
- GP09S 21 — SHALLOW GEOPROBE GROUNDWATER SAMPLE LOCATION WITH TOTAL PAH CONCENTRATION ($\mu\text{g/L}$)
- MW-2S 13 — SHALLOW MONITORING WELL SAMPLE LOCATION WITH TOTAL PAH CONCENTRATION ($\mu\text{g/L}$)
- 10 — TOTAL PAH CONCENTRATION CONTOUR ($\mu\text{g/L}$)

SCALE IN FEET:

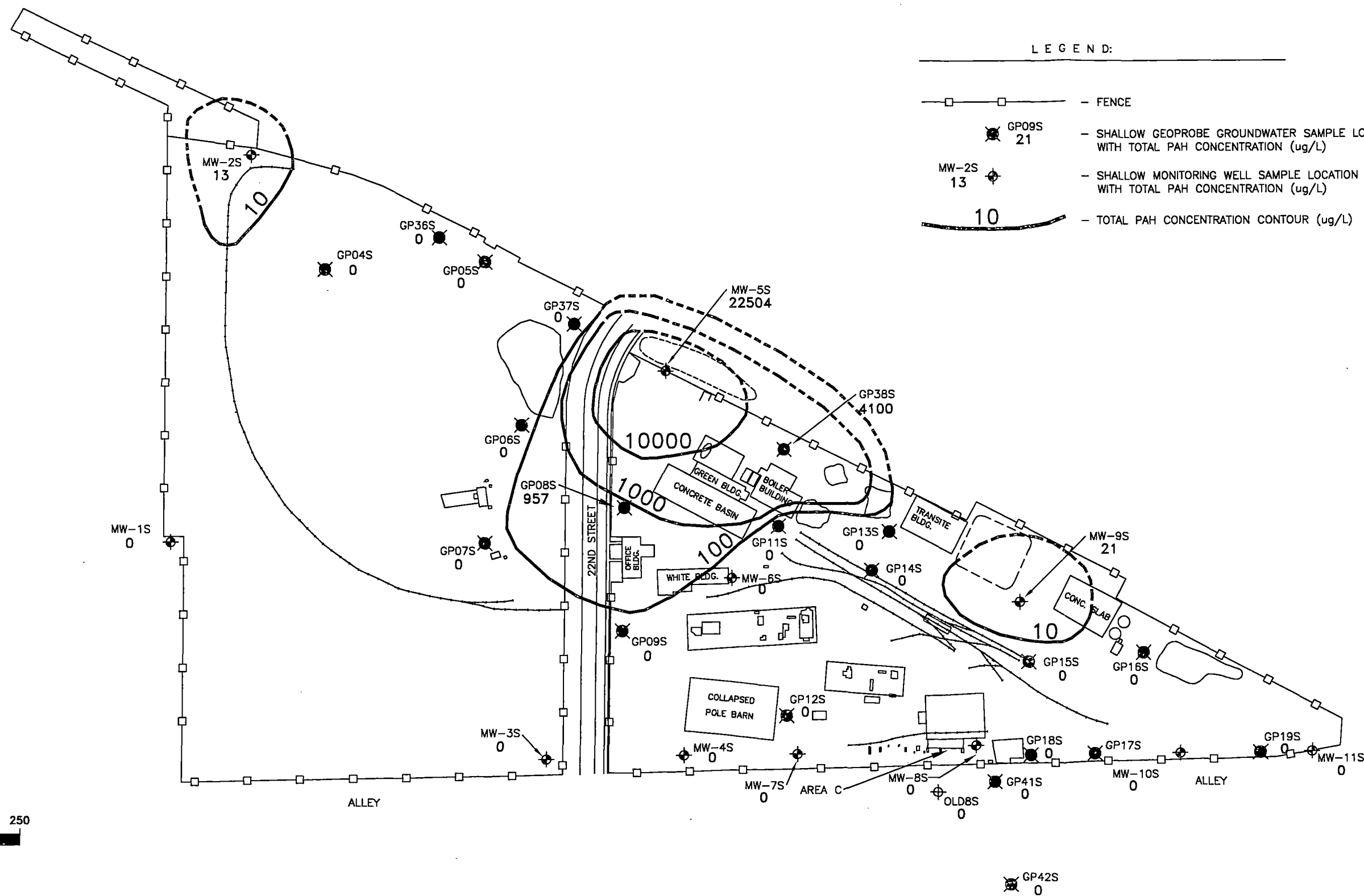
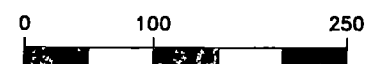


Figure 4-3 TOTAL PAH CONCENTRATIONS IN SHALLOW ZONE GROUNDWATER JENNISON-WRIGHT SITE GRANITE CITY, ILLINOIS



- LEGEND:
- FENCE
 - GP37M 0
INTERMEDIATE GEOPROBE GROUNDWATER SAMPLE LOCATION WITH TOTAL PAH CONCENTRATION (ug/L)
 - MW-9M 10
INTERMEDIATE MONITORING WELL SAMPLE LOCATION WITH TOTAL PAH CONCENTRATION (ug/L)
 - 10
TOTAL PAH CONCENTRATION CONTOUR (ug/L)

SCALE IN FEET:
0 100 250

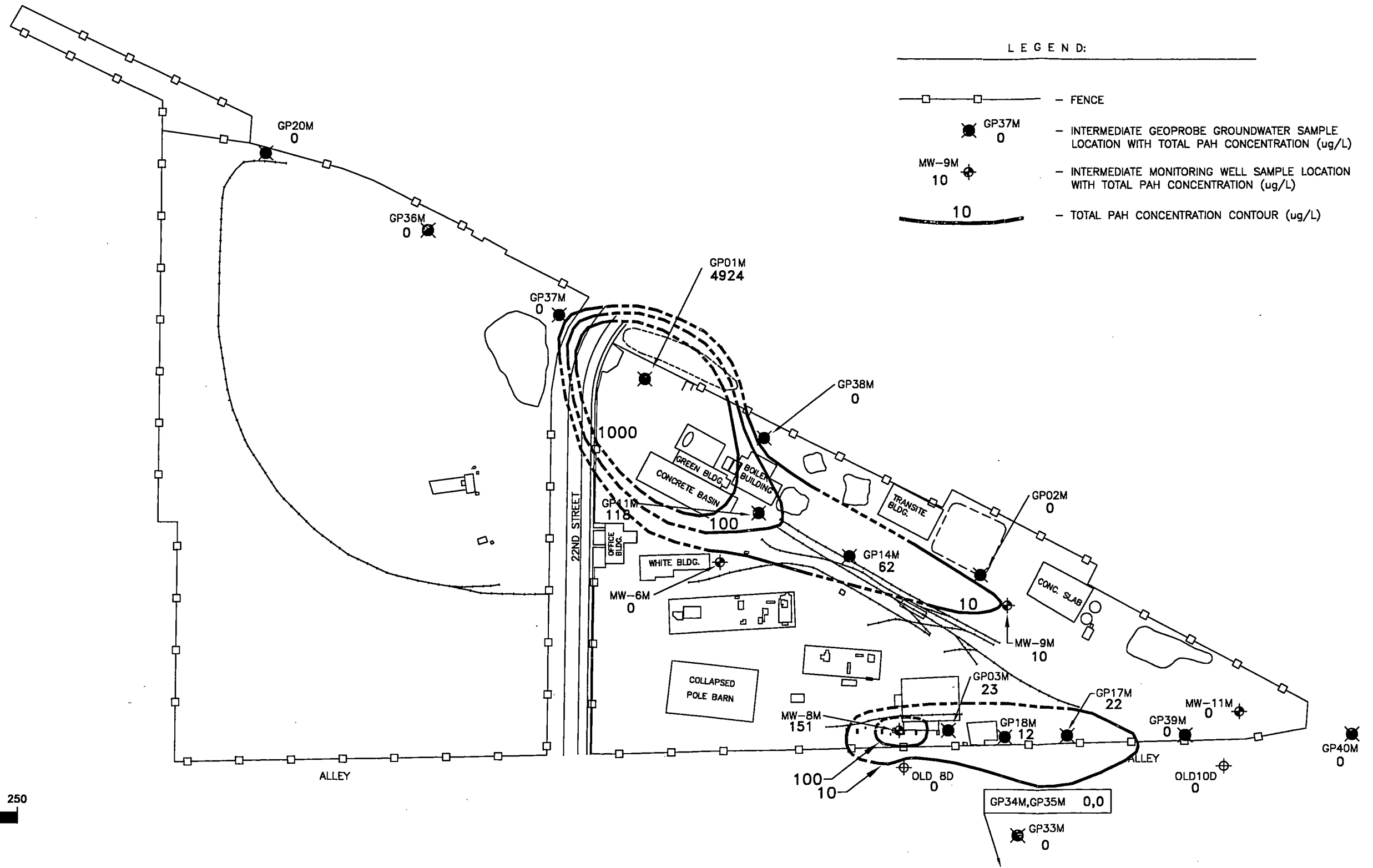
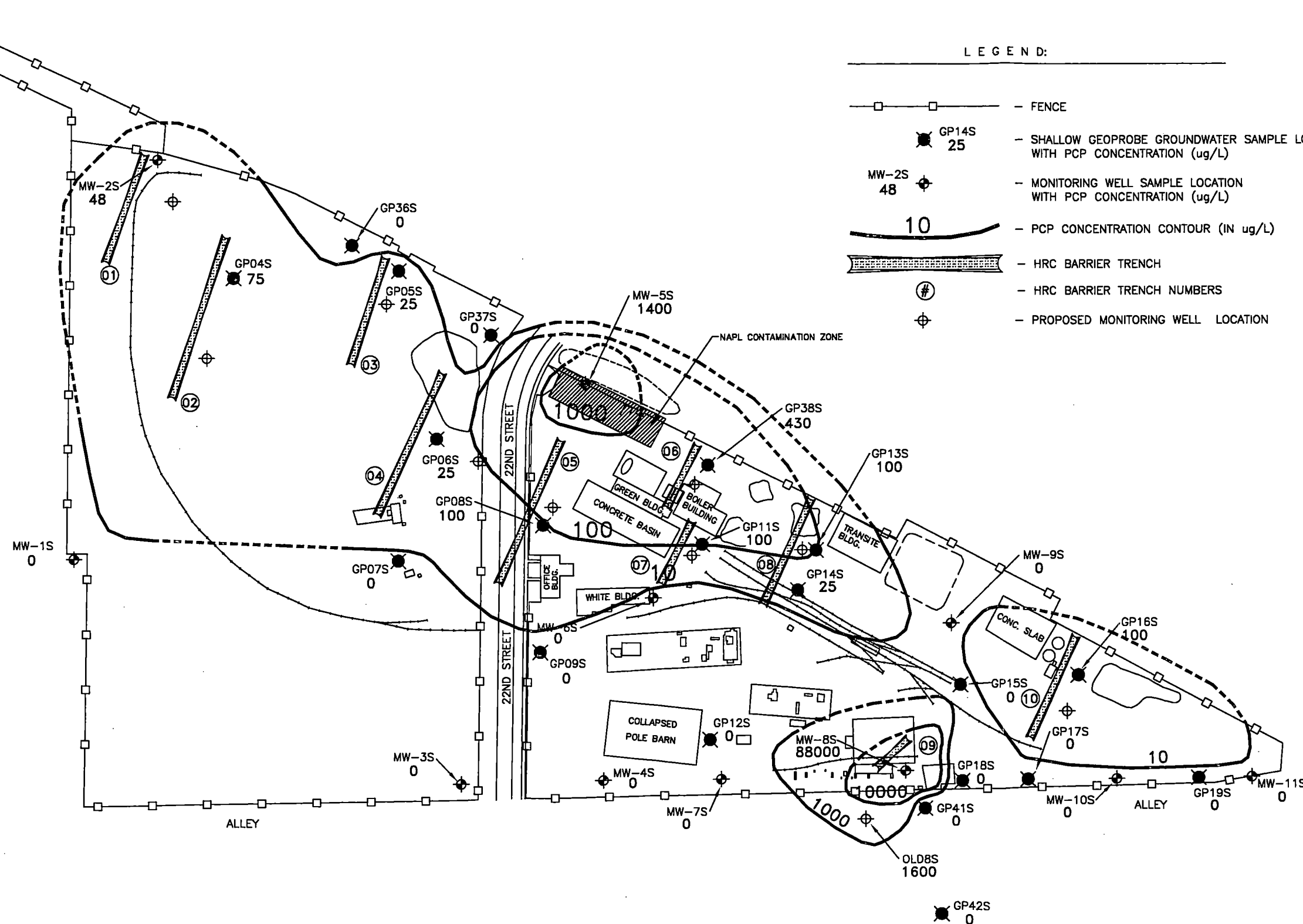


Figure 4-4 TOTAL PAH CONCENTRATIONS IN INTERMEDIATE ZONE GROUNDWATER JENNISON-WRIGHT SITE GRANITE CITY, ILLINOIS



LEGEND:

- FENCE
- GP14S 25 — SHALLOW GEOPROBE GROUNDWATER SAMPLE LOCATION WITH PCP CONCENTRATION (ug/L)
- ⊕ MW-2S 48 — MONITORING WELL SAMPLE LOCATION WITH PCP CONCENTRATION (ug/L)
- 10 — PCP CONCENTRATION CONTOUR (IN ug/L)
- ▨ — HRC BARRIER TRENCH
- # — HRC BARRIER TRENCH NUMBERS
- ⊕ — PROPOSED MONITORING WELL LOCATION



SCALE IN FEET:
0 100 250

Figure 4-5 PCP CONCENTRATIONS IN SHALLOW ZONE GROUNDWATER JENNISON-WRIGHT SITE GRANITE CITY, ILLINOIS



LEGEND:

- FENCE
- GP37M 0 - INTERMEDIATE GEOPROBE GROUNDWATER SAMPLE LOCATION WITH PCP CONCENTRATION (ug/L)
- MW-9M 10 - INTERMEDIATE MONITORING WELL SAMPLE LOCATION WITH PCP CONCENTRATION (ug/L)
- 10 - PCP CONCENTRATION CONTOUR (IN ug/L)

SCALE IN FEET:
0 100 250

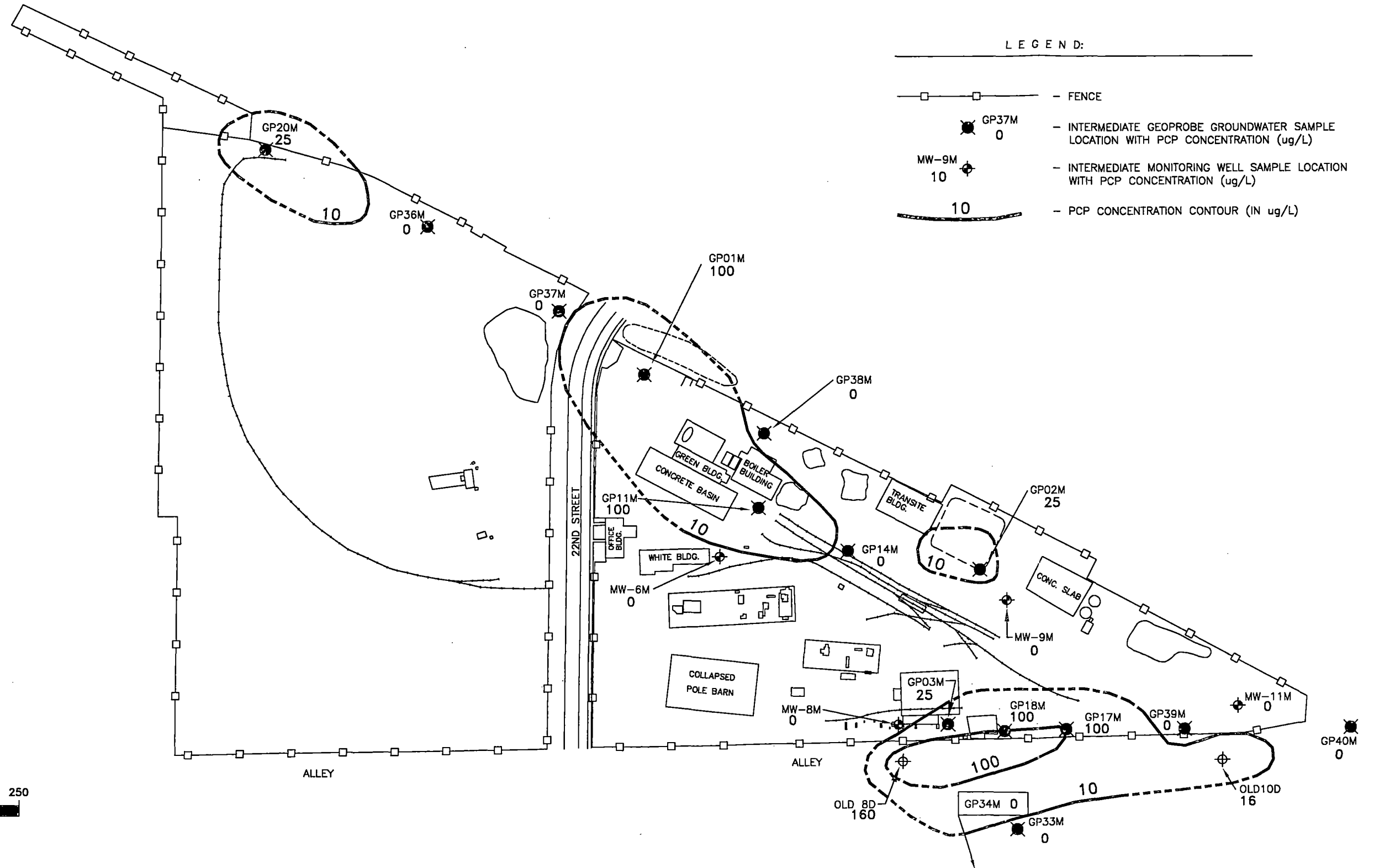


Figure 4-6 PCP CONCENTRATIONS IN INTERMEDIATE ZONE GROUNDWATER JENNISON-WRIGHT SITE GRANITE CITY, ILLINOIS

5

Identification of Alternatives

In this section, removal action alternatives for the following site media and additional items are identified and described:

- Soils and waste,
- NAPLs,
- Groundwater,
- Buildings and silos, and
- Miscellaneous items.

The alternatives identified in this section are screened individually and against one another in Section 6 based on the three broad criteria of effectiveness, implementability, and cost. The site-wide removal action alternative recommended for implementation at the JW site is presented in Section 7.

5.1 The No Action Alternative

Under this alternative, no action would be taken to remove, treat, or contain contaminated soils, wastes, NAPLs, and groundwater at the JW site. Because contaminated media would remain in place, the potential for continued migration of contaminants would not be mitigated. The No Action alternative would not address the site buildings, or the miscellaneous debris piles, USTs, ASTs, or other items, present on site. The continued presence of the site buildings and miscellaneous items would hinder any future brownfields redevelopment of this abandoned site. A brownfields redevelopment involves the redevelopment of abandoned or unused commercial/industrial urban property by removing impediments to that redevelopment. This alternative is applicable to each of the media addressed by this EE/CA (i.e., soils and wastes, NAPLs, and groundwater), but will not be repeated in the following discussions of each medium.

The site-wide No Action alternative has been included as a requirement of the NCP, and to provide a basis of comparison for

5. Identification of Alternatives

the remaining alternatives.

5.2 Soils and Waste

The following alternatives have been developed to address the soils and wastes present at the site that contain concentrations of COPCs above CUOs. An estimated 32,759 cubic yards of surface soil and 22,383 cubic yards of subsurface soil and wastes are present on site containing COPCs above the proposed CUOs. The following removal action alternatives address the contaminated soils and wastes. All of the following soil alternatives include the removal and off-site disposal of RCRA-listed hazardous waste, the abatement of RACM from site buildings, the demolition of site buildings, and the removal/decontamination of concrete foundations and slabs. The removal and disposal of RCRA hazardous waste will be conducted in accordance with RCRA Subtitle C and IEPA's off-site policy. Because RCRA hazardous wastes will be removed from the site, RCRA closure and post-closure requirements are not considered to be ARARs. Details of these removal tasks are provided in Sections 5.5 and 5.6.

5.2.1 Alternative S&W1: 24-Inch Permeable Soil Cover

To implement this alternative, RCRA hazardous waste and all miscellaneous debris present on site, including scrap metal, wood, and trash, would be removed from the site and properly disposed of or recycled. Trees, shrubs, and ground vegetation would be removed, chipped, and graded on site. Once the site was graded, a colored (i.e., orange or yellow) fabric would be placed over the entire area to be covered. This fabric would function as a boundary between contaminated and clean soils. Next, 18 inches of permeable fill material would be placed over the fabric and topped with a 6-inch topsoil layer. The topsoil layer would be seeded with grass chosen for long-term erosion control. A schematic diagram of the cover is shown on Figure 5-1. The proposed permeable cover would encompass the entire 16.6-acre site. PRSC activities associated with this alternative would include cover inspection and maintenance.

This alternative is intended to reduce the potential for direct human exposure to contaminated soil and to minimize migration of contaminants off site through windblown dust particles or by being tracked off site by vehicles or machinery operating on site during demolition, cleanup, and redevelopment activities. Because an impermeable soil cover would not be infiltrated by rainfall, the stormwater would cause ponding on the cover. Construction of effective sewers or drainage ditches to direct stormwater to the stormwater sewer system would be difficult due to the flat nature of the site. Therefore, a permeable cover was selected.

Engineered barriers are not recognized in the development of

5. Identification of Alternatives

TACO Tier 1 cleanup criteria; however, the cover may be considered to be an engineered barrier in the development of Tier 2 or Tier 3 cleanup criteria, pending IEPA approval of the design and materials.

Because contaminated soils and wastes would remain on site, this alternative would also include institutional controls in the form of deed restrictions to limit the potential for human exposure to contaminants. Any future redevelopment of the site (such as a brownfields strategy) would require a reevaluation of the protectiveness of the cover, based on final site configuration and projected use.

ARARs applicable to Alternative S&W1 include pertinent RCRA sections for the removal and disposal of listed hazardous waste. During excavation activities associated with the listed hazardous wastes, dust may be generated. Therefore, dust suppression (RCRA §3004[e]) also would be considered an ARAR. Since the proposed landfill cover is going to be constructed of permeable materials, stormwater will infiltrate through the cover, causing contaminants to continue to leach into the groundwater. Therefore, Title 35, IAC, Part 620, entitled Groundwater Quality, and the SDWA can be considered to be relevant and appropriate. While not an ARAR, TACO CUOs are to be considered for this alternative.

EPA's RCRA guidance states that though a contaminated medium may exhibit characteristics of a hazardous waste, it is not considered a hazardous waste until it is excavated. Additionally, TCLP analysis conducted as part of the site investigation indicates that surface soils, subsurface soil, and sediments at the site do not exhibit characteristics of a hazardous waste. Since no listed hazardous waste will be left on site, and no additional excavations are planned for this alternative, RCRA closure and post-closure requirements and the Treatment Surface Impoundment Exemption (35 IAC 728.104) do not apply.

5.2.2 Alternative S&W2: Landfarming

In this alternative, soils and nonhazardous wastes containing COPCs above CUOs would be treated in an on-site landfarm treatment cell constructed on the northeastern portion of the site. RCRA hazardous waste would not be treated in the landfarm. The wastes that would be treated in the landfarm include those solid and sludge wastes present in Area H, the Jennite Pit, the 22nd Street lagoon, in and beneath the concrete basin, and in sumps and pits. The landfarm treatment cell would consist of a compacted clay liner, drainage system, retention pond, water treatment and discharge system, moisture and nutrient addition equipment, and tilling equipment. Once the soil within the cell was remediated to

5. Identification of Alternatives

the CUOs, the soil would be graded to final contours across the site.

According to EPA's *Presumptive Remedies for Soils, Sediments, and Sludges at Wood Treater Sites*, landfarming is an EPA-recommended technology for wood-treater sites (EPA 1995b). In a landfarming cell, biodegradable contaminants are subjected simultaneously to the following processes: 1) bacterial and chemical decomposition, 2) leaching of water-soluble components, and 3) volatilization of some components of the original waste, as well as certain decomposition products.

In biodegradation, microorganisms consume the contaminants present, forming carbon dioxide, water, and, if chlorinated, hydrogen chloride as end products. The process requires an adequate supply of oxygen, water, and inorganic nutrients (nitrogen and phosphorus). Biodegradation occurs naturally; however, the rate of biodegradation can be severely limited by deficiencies in inorganic nutrients and oxygen, unsatisfactory temperature, and toxic contaminant concentrations in the soil. Adding nutrients and oxygen to the soil enhances the rate of microbial growth and accelerates the degradation of contaminants.

Landfarming techniques have been used successfully to reduce PCP and PAH concentrations in soils at other wood-treating sites in Illinois and across the nation. As previously discussed in Section 2, the biofeasibility study for the JW site concluded that a naturally occurring strain of bacteria, *Alcaligenes eutrophus*, cannot only degrade the contamination present, but can use it as a primary substrate to grow from. Therefore, under the proper conditions, it is likely that landfarming could be used successfully at the JW site.

Soil conditions would be controlled in the treatment cell to optimize the rate of contaminant degradation. Conditions typically controlled include moisture content, oxygen level, nutrients, pH, and soil bulking (i.e., the addition of wood chips, straw, bark, or manure to improve the manageability of the material).

LDRs land disposal restrictions

Surficial soil, subsurface soil, and non-RCRA hazardous wastes would be treated in the landfarm cell. As indicated in Section 4, the results of TCLP analysis indicate that surface and subsurface soil would not be considered RCRA characteristic hazardous waste; therefore, RCRA Subtitle C requirements for TSDFs and land disposal restrictions (LDRs) do not apply to the landfarm cell. Deep excavations remaining after subsurface soil removal would be backfilled with fill material as soon as feasible to prevent the ponding of water in the excavations, and to eliminate the potential of workers or trespassers falling into the excavations. After

5. Identification of Alternatives

excavation, the contaminated soils and wastes would be transported to a soil stockpile area constructed adjacent to the treatment cell. Soil from the stockpile would be placed into the cell to a uniform thickness of 1 foot. This would allow for ease of tilling the soil to increase the oxygen content, and mixing in of nutrients. Using the average concentrations of nitrogen and phosphorus present in site soil, MiL has estimated that the treatment of 55,000 cubic yards of contaminated soil would require approximately 18,000 pounds of nitrogen as N and 3,000 pounds of phosphorus as P. Exact nutrient addition requirements would be determined in the design phase by conducting additional bench-scale testing.

A drawback of landfarming (and all biological treatment) is that inorganics would not be degraded. However, the concentrations of metals in site soils and wastes were not elevated to the point that they pose an unacceptable risk to human health. As shown in Table 4-1, no metals are listed as COPCs for site soils.

For cost estimating purposes, it has been assumed that the landfarm cell would occupy 6.9 acres of the north side's 9.4 acres (approximately 550 feet square). The cell would be surrounded by a clay berm approximately 3 feet high and 3 feet wide. A ramp would be constructed to allow tilling equipment into the cell. The cell floor and berm walls would be constructed of compacted clay.

The landfarm cell would be designed to drain water into an approximately one-million-gallon retention pond (160 feet square by 5 feet deep). Water in the retention pond would be allowed to evaporate. When the water level in the pond approached 80% of full capacity, drawdown of the pond would begin by pumping the water through a carbon filter (as required by Granite City), followed by discharge to the Granite City sanitary sewer system. Permission for this discharge should not pose a difficulty if it is passed through carbon (Parente 1998). The current cost for the discharge would be \$0.86 per 100 cubic feet. The contractor operating the cell would be responsible for metering the discharge. A schematic diagram of the landfarm cell is shown on Figure 5-2.

Based on an area of 6.9 acres and a lift thickness of 1 foot, approximately 11,000 cubic yards of soil would be treated per lift. Considering the climate in the area of the JW site, it is assumed that one soil lift (11,000 cubic yards) would be processed in the treatment cell per year. Based on experience with similar projects, E & E estimates that six years would be required to treat the entire volume of contaminated soil.

The landfarm cost estimate assumes that one soil sample would be collected on a quarterly basis per 1,000 cubic yards of soil within



5. Identification of Alternatives

the landfarm cell, and that each sample would be analyzed for the soil COPCs (see Table 4-1), RCRA characteristic hazardous waste parameters, and nutrient constituents. The purpose of this sampling would be to monitor the progress of the soil treatment, to determine when soil CUOs have been achieved, and to ensure that treated soils do not exhibit RCRA hazardous waste characteristics. This equates to a total of 44 samples to be collected from the landfarm cell annually. In the event that, after one year of treatment, a batch of soil within the cell does not achieve CUOs, it would likely be left in the cell for further treatment. If, after a period of one additional year of treatment, the batch still has not met the CUOs or exhibits RCRA hazardous waste characteristics, the isolated soil would be shipped off site for disposal. Air samples would be collected monthly from one upwind and two downwind monitoring points to ensure that any air emissions from the landfarm are not impacting the surrounding neighborhood. Also included in the cost estimate is the preparation and submittal of a yearly report which would summarize the soil sample analytical results, discuss operational highlights and difficulties, and update the expected time frame to complete soil treatment.

POTW
Publicly Owned
Treatment Works

For Alternative S&W2, activities associated with the removal, dust suppression, transportation, and disposal of listed hazardous waste would be covered by RCRA. Additionally, confirmation sampling and analysis of the open excavation and treated landfarm soils would also be performed to ensure that characteristic hazardous waste was not placed in the landfarm cell, and to identify whether any characteristic hazardous waste was left in place. These activities are governed by RCRA, and the pertinent sections of RCRA that cover these activities are considered to be ARARs for this alternative. Excess stormwater runoff, which may be discharged to the local sanitary sewer system, would be covered by the Publicly Owned Treatment Works (POTW) requirements as set forth by the Granite City Wastewater Department, which are considered to be an ARAR. While TACO is not an ARAR, the CUOs are to be considered for this alternative.

As noted above, EPA's RCRA guidance states that though a contaminated medium may exhibit characteristics of a hazardous waste, it is not considered a hazardous waste until it is excavated. It is the intent of the removal action to reduce risk associated with contaminated site soils and to remove known listed hazardous waste from the site, followed by disposal at an appropriately licensed off-site facility. Additionally, TCLP analysis indicates that surface soils, subsurface soil, and sediments at the site do not exhibit characteristics of a hazardous waste. Therefore, RCRA closure and post-closure requirements and the Treatment Surface Impoundment Exemption (35 IAC 728.104) do not apply. Since confirmation sampling and analysis of the open excavation and



5. Identification of Alternatives

excavated soils will be performed to ensure that hazardous waste will not be placed in the landfarm cell, 35 IAC 728.104, the Treatment Surface Impoundment Exemption, would not be considered an ARAR. Additionally, the soil treated in the landfarm cell will be tested prior to its removal to ensure that cleanup objectives have been met and that the material does not meet the RCRA definition of a characteristic hazardous waste. Therefore, statutory requirements of 35 IAC 808 through 815, which cover solid waste disposal requirements, would not be considered ARARs.

5.2.3 Alternative S&W3: Low-Temperature Thermal Desorption

LTTD

low-temperature thermal desorption

In this alternative, contaminated soil and nonhazardous waste would be excavated and transported to a soil stockpile area located south of 22nd Street, followed by desorption of contaminants from the soils in a mobile low-temperature thermal desorption (LTTD) unit. Treated soil would be graded to final contours across the site.

Per EPA's *Presumptive Remedies for Soils, Sediments, and Sludges at Wood Treater Sites*, LTTD is an EPA-recommended technology for wood treater sites (EPA 1995b). LTTD involves heating soils and waste containing organic contamination in a heated chamber, thereby volatilizing the moisture and organic contaminants. LTTD desorbs organic compounds without heating the soil to combustion temperatures. Inorganic compounds are not treated. The resulting desorbed emissions are passed through emission control units and condensate treatment units. The feed rate, chamber temperature, and residence time of the materials in the chamber dictate the type of contaminants removed, as well as the degree to which the contaminants are removed. A dry solid is produced containing trace amounts of organic residue. These processed solids are cooled with condensed steam to eliminate dust.

An inert gas is used to transport the volatilized water and organics to an off-gas scrubbing system. Once treated, the scrubbed off-gas is vented to the atmosphere. Air permits would be required to operate the LTTD unit. With LTTD treatment, there is a potential for some contaminants with volatilization temperatures above the LTTD operating temperatures to remain in the soil/waste mixture. The LTTD system is designed to treat organic contaminants with boiling points less than 800°F, and soil with less than 10% total organics and moisture. Most thermal units readily treat coarse-grained soils, but require longer processing times and consequently lower throughput rates, for materials with high silt and clay contents.

LTTD units are either fixed or mobile, depending on their size and operating requirements. In this situation, a mobile unit would be

5. Identification of Alternatives

mobilized to the JW site and set up on the south portion of the site. Contaminated and treated soil would also be stockpiled on the south side of the JW site. Treated soil that meets CUOs would be graded to achieve final design contours across the site.

In a typical process, the contaminated material is first heated in an LTTD unit (EPA 1992e). The thermally treated soil is then moved into a conditioner where it is sprayed with water to cool it and minimize fugitive dust emissions. After cooling, the treated soil is stockpiled for analysis and disposal. Desorbed organics from the thermal processor are drawn into a fabric filter. Exhaust gas from the fabric filter is drawn into an air-cooled condenser to remove most of the water vapor and organics. Activated carbon, caustic scrubbers, and afterburners may need to be employed as an air pollution control system to treat exhaust gases. A schematic diagram of the LTTD process is shown on Figure 5-3.

NESHAP
National Emission
Standard for Hazardous
Air Pollutants

During treatment activities, air monitoring would be conducted pursuant to OSHA and National Emission Standard for Hazardous Air Pollutants (NESHAP) regulations to ensure that workers and the public are not exposed to site contamination above allowable levels. Air emission standards and potentially required air pollution control equipment could become a substantial cost and performance factor for on-site LTTD.

Based on the soil volumes requiring treatment, and an overall average feed rate of 2 tons per hour, it is estimated that this alternative would require approximately six years to complete.

The LTTD cost estimate assumes that confirmation samples would be collected at the rate of one per week, for a total of 52 samples annually that would be analyzed for COPCs. In addition, air samples would be collected monthly from one upwind and two downwind monitoring points to determine emission concentrations from the LTTD unit operations. Air samples also would be analyzed for COPCs. Also included in this cost is the preparation and submittal of a yearly report that summarizes the confirmation analytical results and updates the expected time to completion.

ARARs for Alternative S&W3 include RCRA regulations for the removal, dust suppression, transportation, and disposal of listed hazardous waste; and 35 IAC Subtitle B for air permitting of the off-gas from and operation of pollution-control devices for the LTTD unit. Since confirmation sampling of the excavation will be performed to ensure that hazardous waste will not be treated by the LTTD process, 35 IAC 728.104, the Treatment Surface Impoundment Exemption, would not be considered an ARAR. Additionally, the soil treated by the LTTD unit will be tested prior to its placement back in the open excavations to ensure that

5. Identification of Alternatives

cleanup objectives have been met and that the material does not meet the RCRA definition of a characteristic hazardous waste. Therefore, statutory requirements of 35 IAC 808 through 815, which cover solid waste disposal requirements, would not be considered ARARs. While TACO is not an ARAR, the CUOs are to be considered for this alternative.

5.2.4 Alternative S&W4: Off-Site Disposal

Under this alternative, contaminated soil and waste would be excavated, loaded into dump trucks, and transported to an appropriate off-site hazardous waste TSD facility for disposal. The excavated areas would then be backfilled with clean material and seeded. Excavation is an effective method for physically removing contaminated subsurface material from the site. Excavation involves the use of standard construction equipment. There are no limitations on the types of waste that can be excavated and removed. A schematic diagram of this off-site disposal alternative is shown on Figure 5-4.

A TSD facility that would likely be used is PDC in Peoria, Illinois. PDC has previously accepted soil from the JW site for disposal as hazardous waste. F-listed hazardous waste identified at the site will likely go to LWD Field Services, Inc. in Calvert City, Kentucky for incineration and disposal. Other TSD facilities are available as well. Off-site disposal of wastes would be subject to RCRA requirements and to IEPA's off-site disposal policy. Because the contaminated soils and wastes would be disposed of off site, there would be no PRSC activities or institutional controls associated with this alternative. It is estimated that this alternative would take one year to complete.

ARARs for Alternative S&W4 are the same as those for Alternative S&W2 with the following exception. The excavated soils will be classified as either a listed or characteristic hazardous waste. Therefore, statutory requirements of 35 IAC 808 through 815, which cover solid waste disposal requirements, would be considered ARARs. Finally, TCLP results from the site investigation indicated that surface soil, subsurface soil, and sediments are not characteristic hazardous wastes. Based on the analytical results and the previously mentioned EPA RCRA guidance for soils left in place, RCRA closure and post-closure requirements, and the Treatment Surface Impoundment Exemption (35 IAC 728.104) do not apply.

5.3 Non-Aqueous-Phase Liquids

NAPLs are present within the 22nd Street lagoon plume, and it should be noted that NAPL removal is an integral component of the long-term groundwater treatment system, which addresses both on-site and off-site groundwater contamination. The following two

5. Identification of Alternatives

alternatives are proposed to address the NAPLs present in this plume. For both alternatives, further field investigation is necessary to better define the full extent of the NAPLs. This investigation would occur as a pre-design activity.

WRI

Western Research
Institute

CROW

Contained Recovery of
Oily Waste

5.3.1 NAPL1: Hot Water and Steam Flushing

This technology uses hot water and steam to displace and carry NAPLs to a point where they can be collected. A vendor offering this technology is the Western Research Institute (WRI) of Laramie, Wyoming. WRI's patented process is called the Contained Recovery of Oily Waste (CROW) process. In this process, injection and extraction wells are installed in an area contaminated with NAPLs. Steam is injected below the NAPLs, and condenses, causing rising hot water to displace the NAPLs to the extraction wells. Hot water is also added to the subsurface above the steam to further displace the NAPLs. The collected groundwater and NAPL are processed through an oil/water separator with the oil being collected and the majority of the water being reinjected. Any water that is not reinjected is treated (i.e., granular activated carbon or ex situ biodegradation) to pretreatment standards before being discharged to the local publicly owned treatment works.

By removing heavily contaminated material that cannot be readily degraded, the recovery of NAPLs enhances conditions for microbial degradation of the remaining contamination. According to WRI, the process can be used for both shallow and deep contamination, with depth to contamination not being a limiting factor (EPA 1994b). A schematic diagram of the CROW process is shown on Figure 5-5.

WRI was contacted to discuss the potential applicability of the CROW process at the JW site. Based on site-specific information provided by E & E, WRI prepared a conceptual design and cost estimate for construction and operation of a CROW system at the JW site. The following assumptions were made by WRI in preparing the conceptual design:

- There are no tanks or usable equipment on site;
- Six injection wells and two extraction wells would be required, installed in a connected 5-spot pattern;
- Injection wells would be 6 to 8 inches in diameter, and would have three screened intervals (i.e., shallow, intermediate, and deep). The total injection rate would be a minimum of 90 gallons per minute (gpm).
- Extraction wells would be a minimum of 10 inches in diameter and screened through the entire contaminated interval. The

gpm

gallons per minute



5. Identification of Alternatives

total extraction rate would be 10% to 20% greater than the injection rate (i.e., 99 to 108 gpm);

- Five monitoring wells would be required for temperature and water level measurements; and
- Services needed for operating the system would include 480-volt, 3-phase electrical service, natural gas or propane for the heater, a small building or shed to house equipment, and an office trailer.

If the CROW process is selected for implementation, the engineering firm retained by IEPA to perform the design would subcontract WRI to review the design at two stages of completion (i.e., intermediate and pre-final).

The time required until the CROW process has achieved a point of diminishing returns (i.e., volume recovered compared to operating expenses) is estimated by WRI to be between three and four years.

ARARs associated with Alternative NAPL1 include SDWA; Title 35 IAC, Part 620, Groundwater Quality; and 40 CFR Part 145 as administered by IEPA's UIC program. Additionally, the recovered NAPL will have to be disposed of off site. Depending upon the analytical results, the NAPL will be classified as either a characteristic hazardous waste or a special waste. Therefore, either RCRA disposal regulations or statutory requirements of 35 IAC 808 through 815, which cover solid waste disposal, would be the governing ARAR for waste disposal.

5.3.2 NAPL2: Surfactant Flushing

Surfactants are chemical compounds which have the ability to alter the properties of solution interfaces. In surfactant flushing, a surfactant is injected into the NAPL as part of an aqueous solution, with the objective being to lower NAPL-water interfacial tension to the point that physical mobilization of the NAPL takes place. The introduction of a surfactant into the subsurface is referred to as a surfactant flood.

A significant level of effort is required to properly design a surfactant flood. The choice of surfactant at one site may differ significantly from that at another site given variations in contaminant types, geology, and groundwater flow. Typically, a number of laboratory tests need to be carried out as part of the design effort, followed by pilot-scale testing at the site. It is not uncommon to screen the performance of up to 100 different surfactants prior to final selection for a site (AATDF 1997).

At present, there have been no full-scale applications of surfactant

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flushing for which information is readily available (AATDF 1997). Consequently, the technology is regarded as an emerging and not a proven or "off the shelf" technology. However, the time to full-scale application of this technology appears to be short. For this reason, surfactant flushing has been included as a potential NAPL removal alternative for the JW site.

The amount of time required to complete surfactant flushing depends on a number of factors, including the permeability of the subsurface materials, spacing of injection and recovery points, the number of pore volumes required, and the degree of mass removal that is required. The time required for surfactant flushing is thought to be similar to the CROW process (three to four years). A schematic diagram of surfactant flushing is shown on Figure 5-6.

The ARARs for Alternative NAPL2 are identical to those for Alternative NAPL1 (refer to Section 5.3.1).

5.4 Groundwater

In addition to NAPL removal, the following alternatives are proposed to address shallow and intermediate groundwater contamination present within the 22nd Street lagoon and PCP process area plumes. The NAPL removal system, in conjunction with the following groundwater treatment alternatives, forms a long-term groundwater treatment system to address both on-site and off-site groundwater contamination.

The concentrations of COPCs in the other areas of groundwater contamination identified at the site are much lower than in these two plumes. Therefore, it is proposed that these other areas of groundwater contamination be allowed to naturally attenuate, as described below.

5.4.1 Alternative GW1: Natural Attenuation

Natural attenuation makes use of natural biodegradation processes to reduce the concentration and amount of pollutants at contaminated sites. Natural attenuation, also referred to as bioattenuation or intrinsic bioremediation, is an in situ treatment method. Natural attenuation is often used as one part of a site cleanup that also includes the control or removal of the sources of the contamination.

The processes that contribute to natural attenuation are typically acting at many sites, but at varying rates and degrees of effectiveness, depending on the types of contaminants present, and the physical, chemical, and biological characteristics of the soil and groundwater. Natural attenuation processes may reduce contaminant mass (through destructive processes such as biodegradation and chemical transformations); reduce contaminant

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concentrations (through simple dilution or dispersion); or bind contaminants to soil particles, reducing the amount of chemical contaminant migration (adsorption).

The effects of dilution and dispersion appear to reduce contaminant concentration but do not destroy the contaminants. Relatively clean rainwater and snow melt from the ground surface can seep underground to mix with and dilute contaminated groundwater. Clean groundwater from an upgradient location flowing into contaminated areas, or the dispersion of pollutants as they spread out away from the main path of the contamination plume, also leads to reduced concentrations of contaminants in a given area.

Adsorption occurs when contaminants attach or sorb to subsurface soil particles. Most oil-based wood preservatives are hydrophobic (i.e., tend to repel water). When these preservatives have an opportunity to attach to organic matter and clay minerals that also repel water, they do so. Adsorption, like dilution and dispersion, appears to reduce the concentration and mass of contamination in the groundwater, but does not destroy the contaminants.

In certain situations, natural attenuation is an effective, inexpensive cleanup operation and the most appropriate way to remediate some contamination problems. Natural attenuation is sometimes mislabeled as a "no action" approach. However, natural attenuation is really a proactive approach that focuses on the confirmation and monitoring of natural remediation processes rather than relying totally on engineered technologies. Natural attenuation is non-invasive, and, unlike many elaborate mechanical site cleanup techniques, while natural attenuation is working below the ground, the land surface above ground may be used. Natural attenuation is less costly than engineered treatment options, and requires no energy source or special equipment. The biggest drawback of this technology is the long period of time required to achieve CUOs. Based on the high levels of contamination present in the 22nd Street lagoon and PCP process area plumes, a time period of 50 to 100 years, at a minimum, would likely be required to achieve CUOs. It is likely that a lesser period of time would be required to achieve CUOs in the other areas of on-site groundwater contamination.

PRSC activities include the collection of groundwater samples on a quarterly or semiannual basis (semiannual sampling was assumed for cost estimating purposes) to monitor the progress of the natural attenuation.

ARARs associated with Alternative GW1 include SDWA and Title 35 IAC, Part 620, Groundwater Quality.

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5.4.2 Alternative GW2: Enhanced In Situ Bioremediation

Enhanced in situ bioremediation is a process that attempts to accelerate the natural biodegradation process by providing oxygen and nutrients to degrading microorganisms that may otherwise be limited in their ability to biodegrade contaminants.

ORC
oxygen-releasing
compound

The addition of oxygen can be achieved by either sparging air below the water table or circulating hydrogen peroxide throughout the contaminated groundwater zone. Additionally, solid-phase peroxide products (e.g., oxygen-releasing compound [ORC]) can also be used for oxygen enhancement and to increase the rate of biodegradation.

Oxygen Enhancement with Air Sparging. In this technique, air is injected under pressure below the water table to increase groundwater oxygen concentrations. A typical air sparging system has one or more subsurface points through which air is injected into the saturated zone. The air travels up through the saturated zone either in the form of air bubbles or as continuous air channels.

The three main contaminant-removal mechanisms that occur during the operation of air sparging systems include in situ stripping of dissolved organic contaminants, aerobic biodegradation of both dissolved and sorbed-phase contaminants resulting from the delivery of oxygen, and direct volatilization of NAPLs (Nyer 1996). Implementation of air sparging is greatly influenced by the ability to achieve significant air distribution within the target zone. The presence of lower permeability layers will impede the vertical passage of injected air. Homogeneous geologic conditions, such as present at the JW site (with the exception of silts in certain areas of the shallow groundwater zone), are essential for the success of air sparging.

Oxygen Enhancement with Hydrogen Peroxide. During hydrogen peroxide enhancement, a dilute solution of hydrogen peroxide is circulated through the contaminated groundwater zone by pumping the solution into designated injection wells to increase the oxygen content of groundwater and enhance the rate of aerobic biodegradation of organic contaminants by naturally occurring microbes. However, because hydrogen peroxide is a strong oxidizer and can be dangerous if handled improperly, it is the least preferred method of oxygen enhancement.

Oxygen Enhancement with ORC. There are several methods for the introduction of ORC into the subsurface. In the most common method, ORC is placed into "socks," which are linked and lowered into a well. A schematic diagram of this method is shown on Figure 5-7. The ORC slowly releases oxygen to the groundwater

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flowing through the well. Another approach is to inject ORC directly into the aquifer by grouting techniques.

For the JW site, it appears that both air sparging and ORC could be used effectively for oxygen enhancement. For the groundwater contamination plume in the PCP process area, which extends vertically only to the intermediate depth of the aquifer (i.e., 50 to 60 feet BGS), ORC socks would be the preferred method of oxygen enhancement. Existing monitoring wells MW8S and MW8M would be used for sock placement. Also, eight to 12 additional monitoring wells (both shallow and intermediate) would be required in the PCP process area for sock placement. Exact well placements would be determined in the removal action design phase.

Deep groundwater exceedances of CUOs were detected in one groundwater monitoring well (MW5D) located in the 22nd Street lagoon area. Since there is the potential for the selected NAPL removal alternative for this area to increase deep groundwater contamination, it was necessary to develop a groundwater alternative; air sparging would be the preferred technique. This is especially true because the injection and extraction wells installed during the NAPL removal phase could be converted to air sparging wells at the completion of removal. Additional smaller-diameter sparging points may also be required. Again, the determination of the exact number of air sparging points would be determined in the design phase.

Two nutrients required by microorganisms are nitrogen and phosphorus. The most common sources of nitrogen and phosphorus are ammonia and nitrate, and phosphates, respectively. These nutrients are typically introduced into the subsurface by pumping liquid forms into monitoring, injection, and/or extraction wells.

ARARs associated with Alternative GW2 include SDWA and Title 35 IAC, Part 620, Groundwater Quality. Since nutrients will be added to groundwater, 40 CFR Part 145, as administered by IEPA's UIC program, also is considered to be relevant and appropriate.

5.4.3 Alternative GW3: Ex Situ Biological Treatment

Ex situ biological treatment through the use of bioreactors degrades contaminants in water with microorganisms through suspended or attached biological systems, which are installed in an aboveground treatment building. A schematic diagram of this system is presented on Figure 5-8. In suspended growth systems, such as activated sludge, fluidized beds, or sequencing batch reactors, contaminated groundwater is circulated in an aeration

5. Identification of Alternatives

basin where a microbial population aerobically degrades organic matter and produces carbon dioxide, water, and new cells. The cells form a sludge, which is settled out in a clarifier, and is either recycled to the aeration basin or disposed of. In attached growth systems, such as upflow fixed film bioreactors, rotating biological contactors, and trickling filters, microorganisms are established on an inert support matrix to aerobically degrade water contaminants. The microbial population may be derived either from the contaminant source or from an inoculum of organisms specific to a contaminant. Nutrients are often added to the bioreactors to support the growth of microorganisms. Bioreactors are used primarily to treat SVOCs, fuel hydrocarbons, and any biodegradable organic material, including most VOCs. The process may be less effective for some pesticides.

In an ex situ biological treatment system, contaminated groundwater would be removed from the subsurface by a series of extraction wells and pumped into a newly constructed treatment building. BioTrol, a vendor offering ex situ biological treatment systems, was contacted to obtain information on their systems. BioTrol provided information on their BioAccelerator, which is an engineered system designed for the biological treatment of water containing organic contaminants.

The BioAccelerator treatment system consists of an oil/water separator; a bioreactor including aeration, nutrient feed, and pH control systems; a gravity clarifier; and carbon filters. After passing through the BioAccelerator, treated groundwater could be either discharged to the sanitary sewer or reinjected into the subsurface downgradient of the site's groundwater contaminant plumes. For cost estimating purposes, it was assumed that the treated groundwater would be discharged to the sewer.

ARARs associated with Alternative GW3 include SDWA and Title 35 IAC, Part 620, Groundwater Quality, and the POTW requirements as set forth by the Granite City Wastewater Department.

5.5 Buildings

In order to obtain a comprehensive soil removal alternative at the JW site, soils beneath the existing foundations of site structures will have to be addressed. Based on data obtained during the site investigation, it is likely that contaminant levels beneath the foundations exceed the established CUOs. Therefore, building demolition and the removal of the concrete foundations will have to be performed in order to address the subfloor soil contamination as part of the selected soil removal alternative. During the design phase, either Geoprobe sampling or manual borings through the foundations could be performed to collect the necessary data for

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the characterization of the subfloor soils and to determine the extent of contamination. Additionally, foundation samples could be collected and analyzed to determine whether decontamination is needed prior to disposal.

There are five buildings and two silos on site. The buildings are referred to as the office building, the white building, the green building, the boiler building, and the Transite building. The only known hazardous material associated with the buildings is RACM. Based on the report prepared by R & M (see Appendix E), and to facilitate the implementation of the soil removal action at the site, RACM in the on-site buildings will be abated prior to demolition of the buildings and silos. For cost estimating purposes, it has been assumed that the concrete floor slabs of the buildings and silos would be decontaminated using high-pressure water washing, then crushed, and shipped off site for disposal. Any floor drains encountered during the demolition would be emptied, decontaminated, and shipped off site for disposal. The total estimated amount of concrete foundation or slab material on site is 1,801 cubic yards. Decontamination wash water used for concrete and drains would be treated by the proposed groundwater treatment system or containerized and shipped off site for disposal.

Table 5-1 provides the amount of RACM present in the structures on the JW site. The total estimated amount of RACM on site is 181 linear feet on pipes, and 7,085 square feet on other structural components.

Because the total square footage on other structural components exceeds the exemption area of 160 square feet, the abatement and notification requirements of 40 CFR Part 61.145 paragraphs (b) and (c) would be applicable to the demolition of the JW structures.

RACM abatement is achieved through the appropriate selection of one or more of the following five accepted techniques: removal, encapsulation, encasement, enclosure, and repair. Because the on-site buildings would be demolished following the RACM abatement, removal of RACM is the abatement technique that should be used at the JW site. Of all the available abatement techniques, removal offers the most satisfactory long-term solution.

Before RACM abatement would begin, the work areas where RACM is present would be prepared in a manner that would protect human health and the environment. Since the disturbance of RACM during removal generates airborne asbestos fibers that may remain suspended in the air for a long time, work areas must be prepared to contain fibers during the entire removal process. A common method of containment is to install polyethylene sheeting

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on walls, the floor, and the ceiling. Construction of temporary walls using pine studs and polyethylene sheeting would likely be required.

Removed RACM (with the exception of the transite panels) would be placed into specially made disposal bags and transported to an off-site landfill for disposal. The transite panels, after being carefully removed from the walls of the Transite building to prevent the release of asbestos fibers, could be loaded directly into dump trucks for transport to the landfill.

The abatement of RACM at the JW site would be performed by a contractor trained and certified to perform this work, and under the supervision of IEPA and Granite City officials.

As stated in Section 4.2.1, the applicable ARAR for demolition of buildings with asbestos-containing material is 40 CFR Part 61.145.

5.6 Miscellaneous Items

This group consists of the following items present on the site:

- Two empty USTs,
- Two ASTs that contain oil,
- An oil/water separator that contains rainwater,
- Rainwater and sediments present in the concrete basin,
- Several sumps and pits that contain oily waste,
- The collapsed pole barn,
- Scattered debris piles consisting of varying amounts of concrete, scrap metal, wood, and trash, and
- steel tram rail.

Because the above items are structures and no treatment technologies are needed, only one alternative for managing these items, removal, is presented here. Removal of the miscellaneous items is necessary to facilitate the implementation of a removal action to address soils and wastes, NAPLs, and groundwater.

As an integral part of the soil alternative, the ASTs, oil/water separator, and concrete basin should be incorporated into the site-wide removal action. These structures contain waste materials that could potentially be released, thereby contaminating remediated or clean soils. Additionally, soils beneath these structures have

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contaminant levels above the established CUOs. If the structures are left in place, contaminated soils still will remain on site at the completion of the soil removal alternative. The following removal methods are proposed for these structures.

The oil present in the two ASTs should be removed, containerized, and disposed of or recycled off site. The ASTs should then be cleaned and scrapped.

The rainwater present in the oil/water separator should be removed, passed through carbon, and discharged to the sanitary sewer system. Permission from the Granite City wastewater department would be required for this discharge, and a fee would be assessed. The oil/water separator should then be cleaned and scrapped.

Rainwater present in the concrete basin should be removed, passed through carbon, and discharged to the sanitary sewer. Sediments present in the concrete basin should be removed and handled in the same manner as the site's soils and wastes. For example, if the soils and wastes are to be treated in a landfarm, the concrete basin waste should be treated in the landfarm as well. Once emptied, the basin should be demolished and removed from the site.

Solid and sludge waste present in the sumps and pits should be removed and handled in the same manner as the site soils and wastes. The sumps and pits would then be demolished and removed from the site.

In order to gain access to surface and subsurface soils that contain contaminants above the CUOs, the debris piles, steel tram rails, and USTs should be removed. The removal method is as follows:

The debris piles should be segregated into wastestreams (i.e., steel, wood, concrete, and trash), with each wastestream being disposed of or recycled as appropriate.

Steel tram rail should be excavated, cleaned to the extent feasible on an on-site decontamination pad, and either scrapped or disposed of off site.

The two empty USTs should be excavated, removed, cleaned, and scrapped. No residual fuel sludge appears to be present in the USTs.

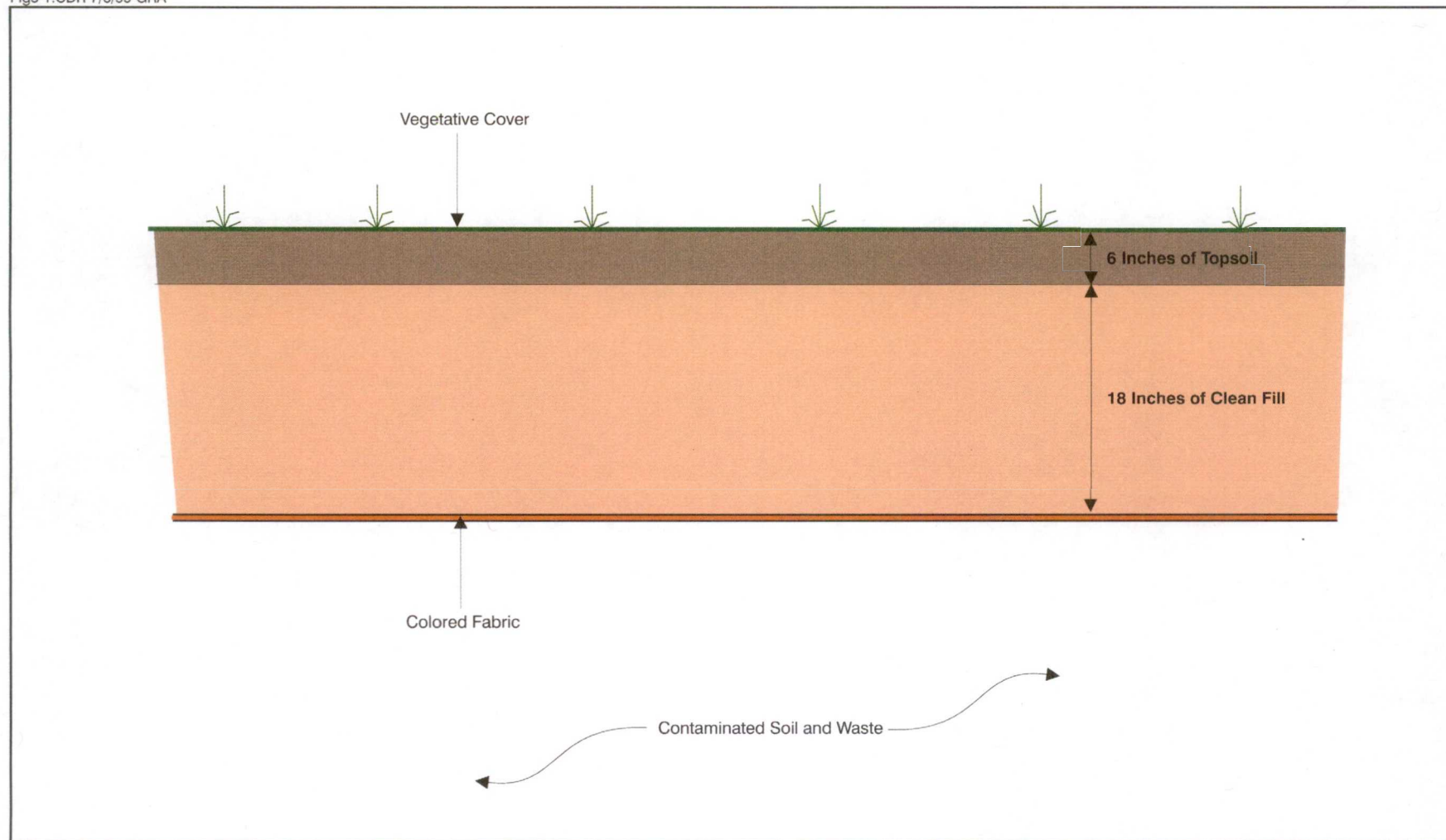
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Table 5-1 REGULATED ASBESTOS-CONTAINING MATERIAL JENNISON-WRIGHT SITE GRANITE CITY, ILLINOIS		
RACM	Quantity	Category
White Building Boilerjacket	85 square feet	Friable ACM
White Building Pipe Runs	101 linear feet	Friable ACM
Boiler Building Pipe Runs	80 linear feet	Friable ACM
Transite Building Panels	7,000 square feet	Category II ACM

Note: The total amount of RACM is 181 linear feet on pipes and 7,085 square feet on other structural components.

Key:

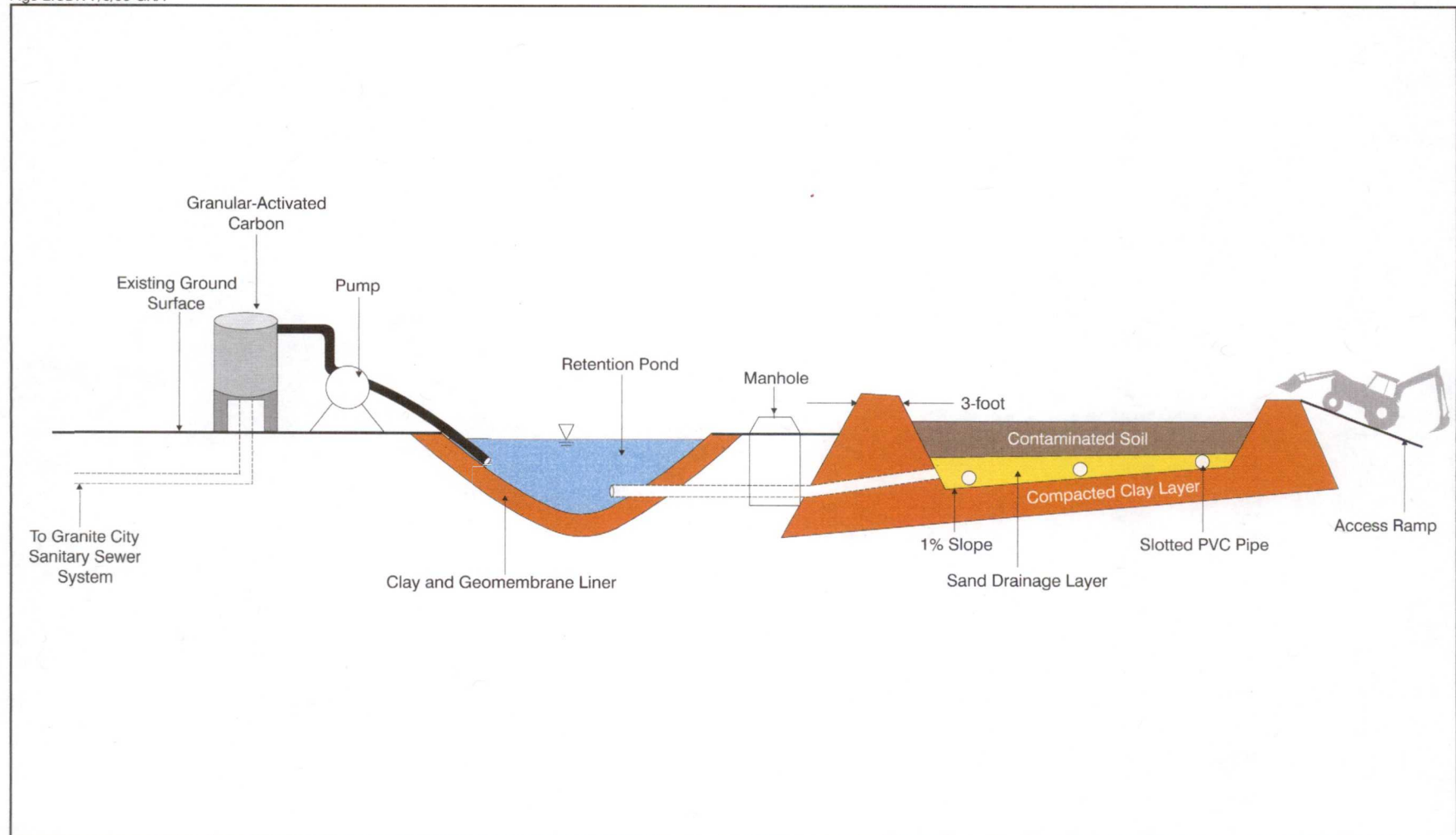
ACM = Asbestos-containing material.
RACM = Regulated ACM.



SOURCE: Ecology and Environment, Inc., 1998

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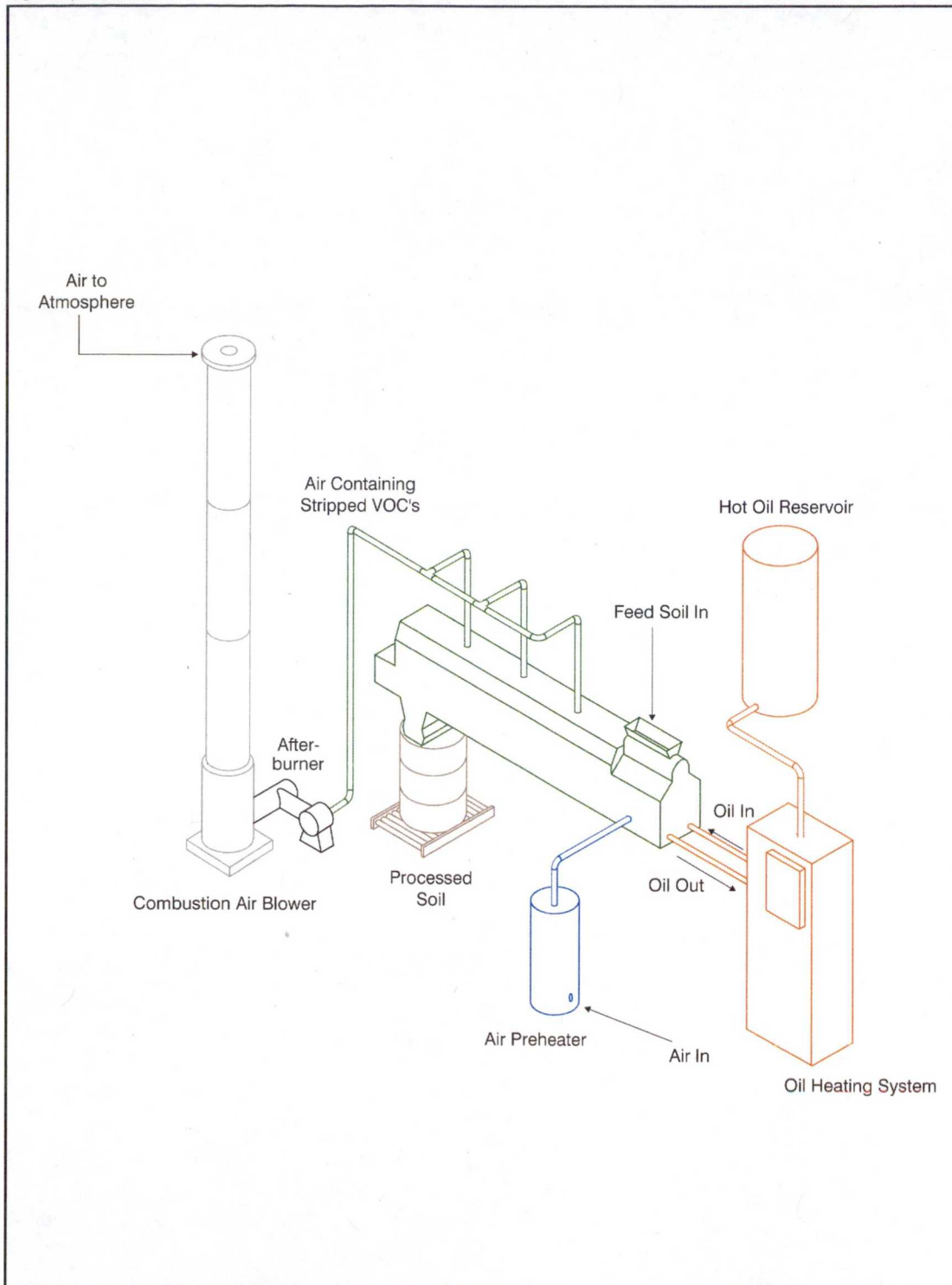
**Figure 5-1 ALTERNATIVE S&W1 - 24-INCH PERMEABLE COVER SCHEMATIC
JENNISON-WRIGHT SITE
GRANITE CITY, ILLINOIS**



SOURCE: Ecology and Environment, Inc., 1998

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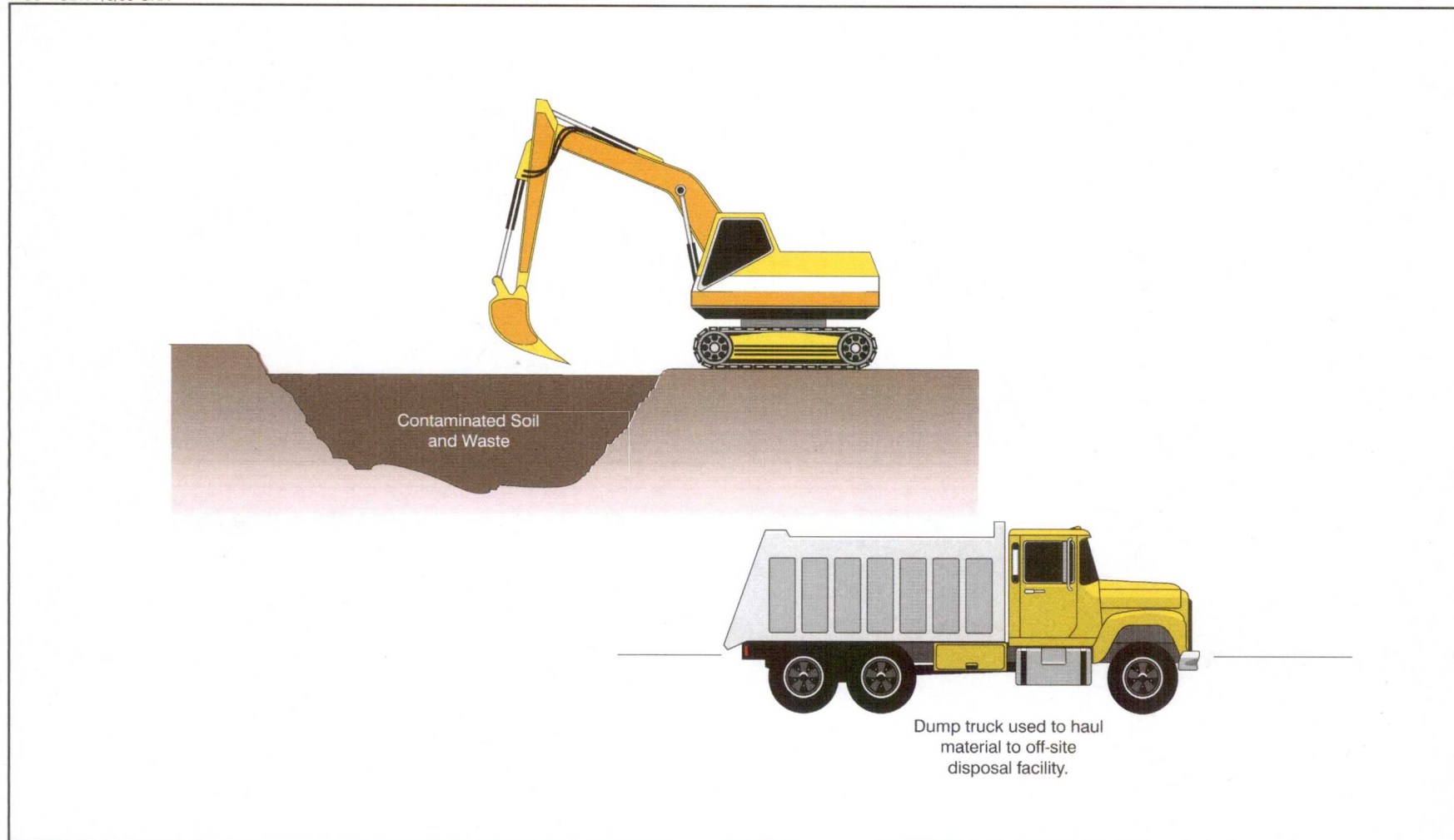
**Figure 5-2 ALTERNATIVE S&W2 - LANDFARM SCHEMATIC
JENNISON-WRIGHT SITE
GRANITE CITY, ILLINOIS**



SOURCE: RS Means Environmental Remediation Cost Data, 1998

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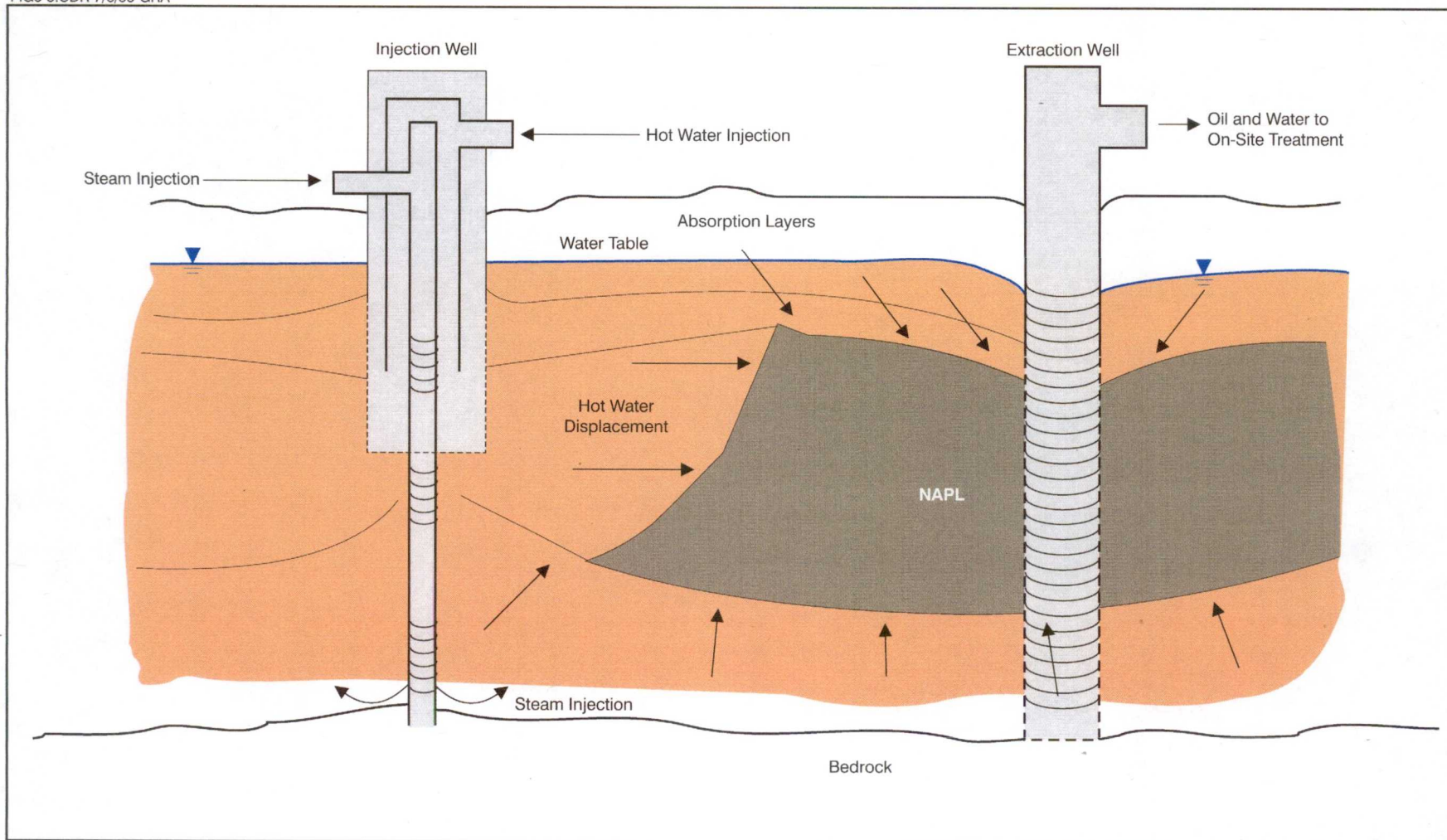
Figure 5-3 **ALTERNATIVE S&W3 - LOW TEMPERATURE THERMAL
DESORPTION PROCESS SCHEMATIC
JENNISON-WRIGHT SITE
GRANITE CITY, ILLINOIS**



SOURCE: Ecology and Environment, Inc., 1998

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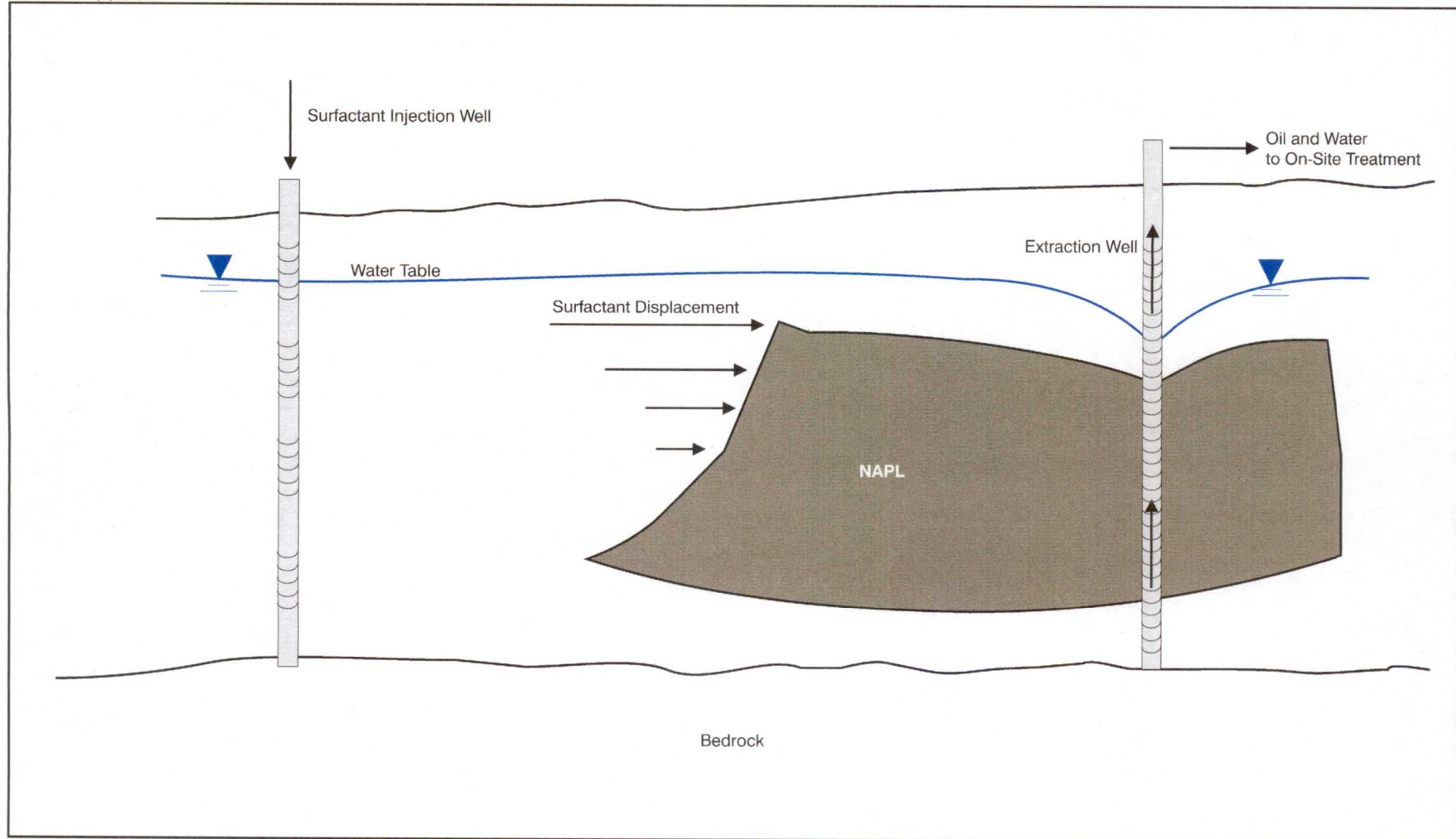
**Figure 5-4 ALTERNATIVE S&W4 - OFF-SITE DISPOSAL SCHEMATIC
JENNISON-WRIGHT SITE
GRANITE CITY, ILLINOIS**



SOURCE: Western Research Institute

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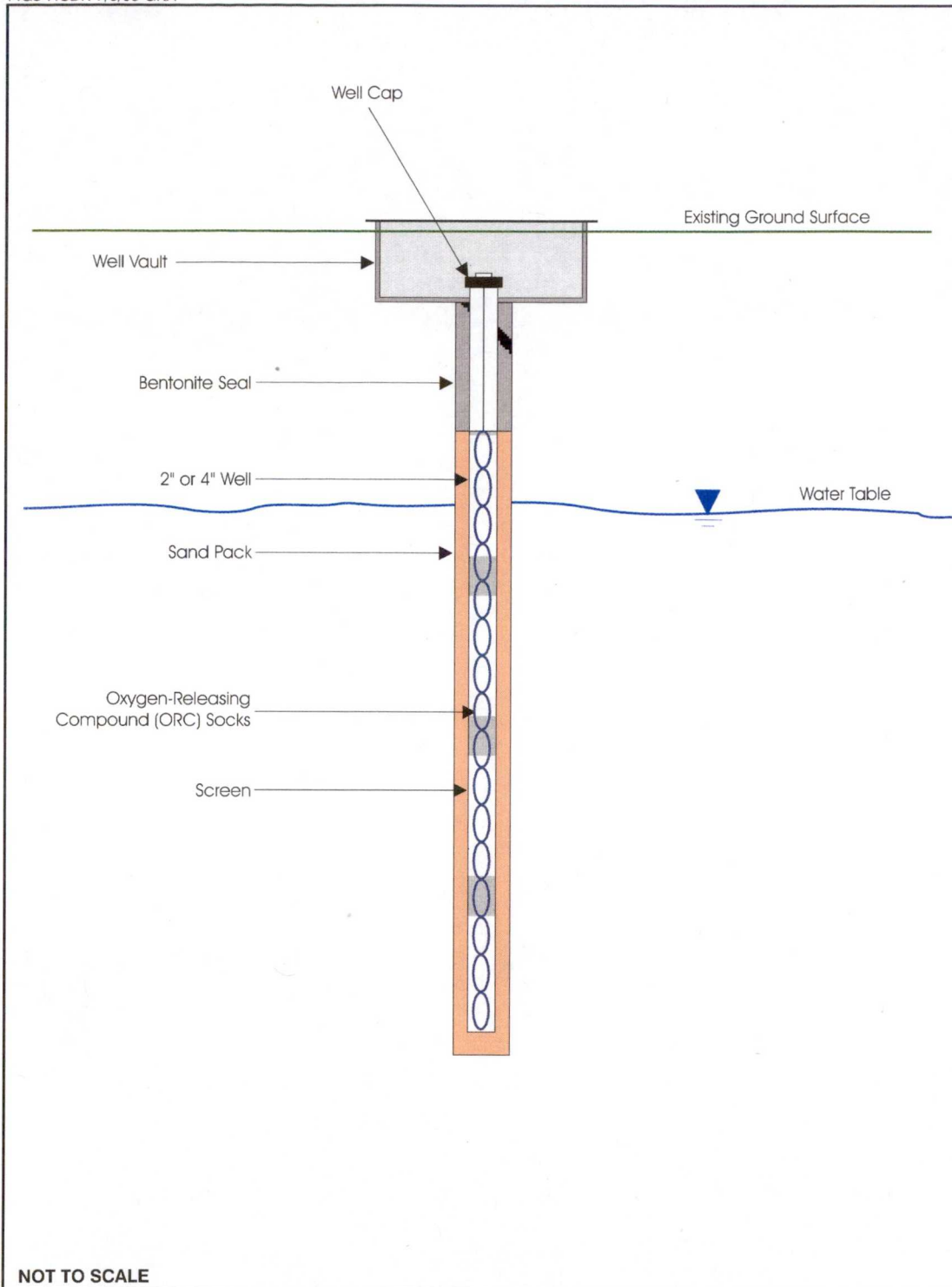
Figure 5-5 **ALTERNATIVE NAPL 1 - CROW PROCESS SCHEMATIC**
JENNISON-WRIGHT SITE
GRANITE CITY, ILLINOIS



SOURCE: Ecology and Environment, Inc., 1998

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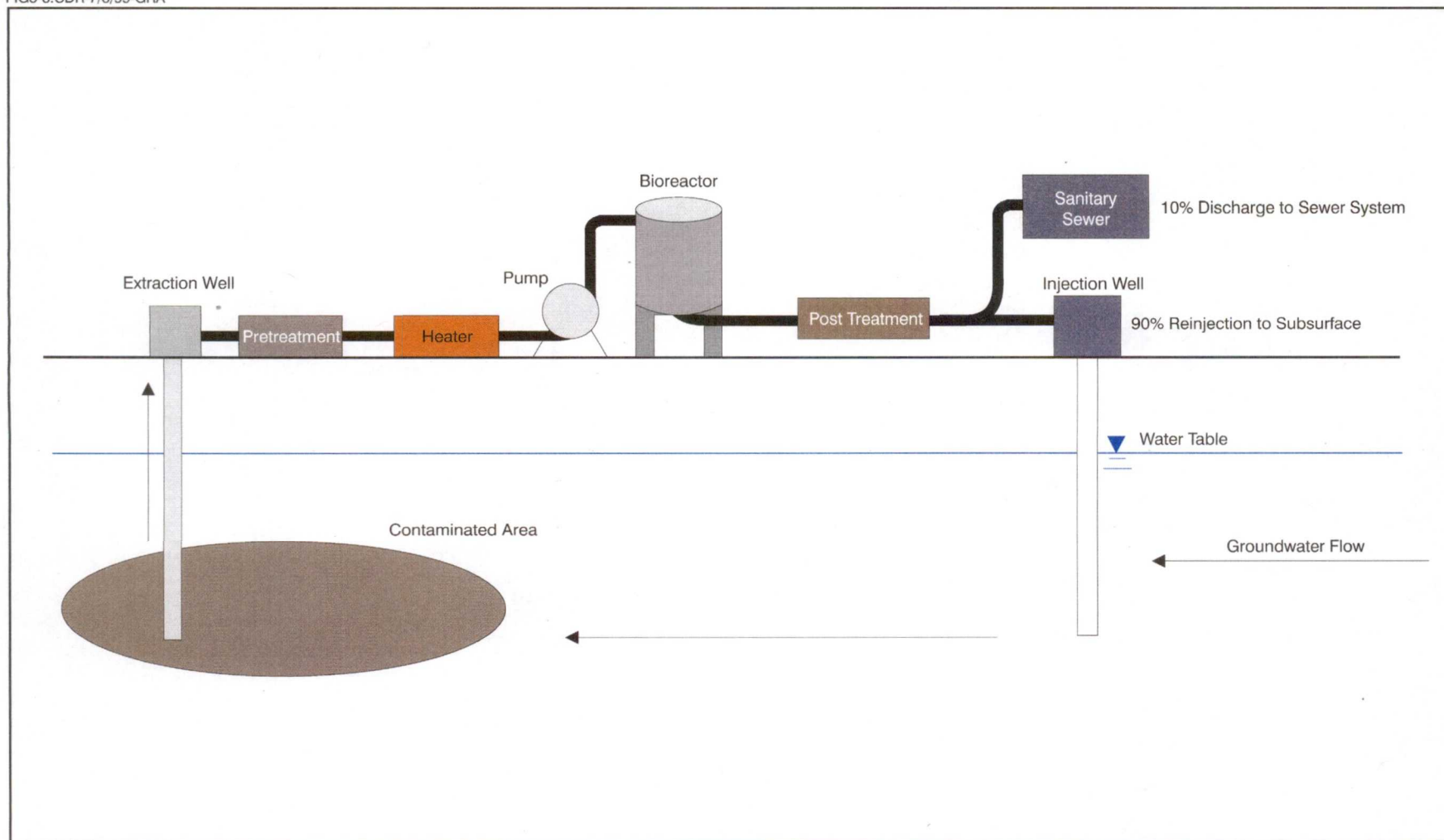
Figure 5-6 **ALTERNATIVE NAPL 2 - SURFACTANT FLUSHING SCHEMATIC**
JENNISON-WRIGHT SITE
GRANITE CITY, ILLINOIS



SOURCE: Ecology and Environment, Inc. 1998

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**Figure 5-7 ALTERNATIVE GW2 - ENHANCED IN-SITU
BIOREMEDIATION - ORC WELL SCHEMATIC
JENNISON-WRIGHT SITE
GRANITE CITY, ILLINOIS**



SOURCE: Ecology and Environment, Inc., 1998

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Figure 5-8 **ALTERNATIVE GW3 - EX-SITU BIOLOGICAL TREATMENT SCHEMATIC**
JENNISON-WRIGHT SITE
GRANITE CITY, ILLINOIS

6

Detailed Analysis of Alternatives

In Section 5, a limited number of removal action alternatives were identified for soils and wastes, NAPLs, and groundwater. In this section, these removal action alternatives are evaluated individually and against one another in terms of effectiveness, implementability, and cost. These criteria are described as follows:

- **Effectiveness**—This criterion refers to the ability of an alternative to meet the objectives of the removal action, and to be protective of human health and the environment. Specifically, the effectiveness of an alternative is measured by the degree to which the alternative protects overall public health and the environment, complies with ARARs, and reduces the toxicity, mobility, or volume of COPCs in both short-term and long-term scenarios.
- **Implementability**—Each alternative is evaluated to determine its technical and administrative feasibility, including the availability of the services and materials associated with the technology. Factors considered in evaluating the implementability of an alternative include the degree of difficulty in constructing and operating the technology; scheduling considerations; permitting requirements and coordination with regulatory agencies; potential impacts on the surrounding community; and off-site treatment, storage, and disposal capacity.
- **Cost**—For each alternative, an estimate of direct and indirect capital costs, as well as a long-term PRSC cost, is developed. Cost will be a factor in comparing alternatives that can produce similar levels of protection for potential receptors. For removal action alternatives that are anticipated to last longer than 12 months, the present worth of the alternative is calculated (EPA 1993).

CLU-IN
Clean-Up Information

Removal action alternatives presented in this section are analyzed utilizing the best available information. Technical information was gathered from vendors, available EPA guidance documents, and on-line databases such as Hazardous Waste Clean-Up Information

6. Detailed Analysis of Alternatives

(CLU-IN) and Vendor Information System for Innovative Treatment Technologies (VISITT). CLU-IN is available on the World Wide Web at www.clu-in.com.

VISITT
Vendor Information
System for Innovative
Treatment Technologies

Prior to the implementation of the selected removal action for the JW site, bench- and pilot-scale treatability studies would have to be undertaken to evaluate the treatability of the contaminated medium and the ability of the treatment technology to meet CUOs. The treatability studies would also determine the specific characteristics of any treatment residuals.

Because of the uncertainties associated with the estimated extent of contamination, the treatability of the contaminated media, and the nature of the process residuals, the cost estimates presented in this section should not be considered final removal action costs. Instead, the estimates represent preliminary cost estimates either supplied by vendors working with a limited knowledge of the site-specific conditions, or obtained from 1998 R.S. Means Company, Inc. cost estimating books. These estimates were used as a basis for comparing relative costs and for evaluating technologies.

6.1 The No Action Alternative

The no action alternative was evaluated to provide a baseline to which other alternatives can be compared, as required by the NCP. Under this alternative, contaminated soils and wastes, NAPLs, and groundwater would be left in their present condition. The no action alternative is evaluated only once in this section; the evaluation will not be repeated for each medium evaluated (i.e., soils and wastes, NAPLs, and groundwater). Even though the evaluation does not carry through, no action is an alternative for each medium.

Effectiveness. Protection of human health and the environment is not provided by this alternative. Levels of contaminants and existing and future risks to human health and the environment would remain unchanged. Since media containing COPCs that exceed the CUOs would be left on site without any protective barriers or controls, the removal action objectives established for the JW site would not be achieved. The no action alternative offers no long-term effectiveness or permanence. Additionally, this alternative provides no reduction in the toxicity, mobility, or volume of contaminants.

Implementability. This alternative is readily implementable since there are no technologies that have to be implemented, administrative coordination is not required, and there are no labor, equipment, material, or laboratory services to be obtained.

6. Detailed Analysis of Alternatives

Cost. There are no costs associated with this alternative.

6.2 Soils and Wastes

This section evaluates the removal action alternatives that were developed to address site soils and wastes. The evaluation presented in this section highlights the most significant elements of effectiveness and implementability. Further evaluation of the soils and wastes alternatives is presented in Table 6-1.

A common component of all the soil and waste alternatives (with the exception of the No Action Alternative) is the removal and off-site disposal of approximately 300 cubic yards of listed hazardous waste. The removal design will specify the appropriate method for excavation, frequency and contaminants associated with confirmation sampling, transportation and manifesting requirements, and the location of an off-site incineration facility that has the appropriate licenses. By incorporating these necessary removal parameters in the removal design, requirements set forth in RCRA concerning the listed hazardous waste shall be met. With all listed hazardous waste being removed from the site and confirmation sampling being performed, LDRs will not be applicable to the remaining soils and wastes, which will be addressed by further removal actions at the site. Therefore, the ARARs associated with RCRA transportation and disposal will have been met.

The cost for excavating, transporting, and off-site incineration of approximately 300 cubic yards of listed hazardous waste is \$400,000. Since items associated with field overhead and oversight, health and safety monitoring, and mobilization of general equipment are common components for each of the soil and waste alternatives and, given the relatively low volume of listed hazardous waste, these costs have not been factored into the removal cost for the listed hazardous waste. If only the listed hazardous waste was to be addressed by a separate removal action, the cost would be approximately \$540,000.

While addressed separately in Sections 6.5 and 6.6, buildings and miscellaneous items are critical components of the soil and waste alternatives. It should be noted that if these items are not implemented, soil with contaminant concentrations above the CUOs still would be present on site at the completion of the soil removal action. Additionally, vessels containing waste material would remain on site. Therefore, there would be the potential for a release and further spreading of the contaminants into adjacent clean soil and groundwater.

6.2.1 Alternative S&W1: 24-Inch Permeable Soil Cover

In this alternative, a permeable soil cover consisting of 18 inches

6. Detailed Analysis of Alternatives

of fill and a 6-inch vegetative layer would be placed over the entire site, once demolition, clearing, and grubbing were completed. The removal design will incorporate measures to minimize dust generation. Therefore, the dust suppression ARAR will be met. It should be noted that no listed hazardous waste will be left in place and/or covered by the soil barrier. Since the soil cover will be made of a permeable material, stormwater will migrate through the cover and into contaminated soil, causing contaminants to leach into the groundwater. Therefore, ARARs associated with the SDWA and groundwater quality (35 IAC Part 620) will not be met. Since TACO Tier 2 and Tier 3 regulations allow the use of engineered barriers to reduce the exposure to contaminants of concern, the soil cover would meet the TACO CUOs, assuming approval by IEPA.

With a soil cover, contamination would remain in place, but direct contact would be prevented. This alternative is readily implementable, with contractors, equipment, and the cover materials readily available. Further evaluation of the cover is presented in Table 6-1. The present worth estimated cost for this alternative is \$2,060,000. Details of this cost estimate are presented in Table 6-2. Refer to Appendix L for costing documentation.

6.2.2 Alternative S&W2: Landfarm

In this alternative, contaminated soils and wastes would be excavated and transported to an engineered landfarm cell located in the northeastern portion of the JW site. After treatment in the cell, the treated material would be graded across the site and vegetated.

Confirmation sampling will be conducted on the open excavation to identify the potential for in situ soil to be identified as being a potential source for a characteristic hazardous waste. It should be noted that no listed hazardous waste will be treated by the landfarm cell. EPA's RCRA guidance states that though contaminated media may exhibit characteristics of a hazardous waste, it is not considered a hazardous waste until it is excavated. It is the intent of the removal action to reduce risks associated with contaminated site soils and to remove known listed hazardous waste from the site, followed by incineration at an appropriately licensed off-site facility. Additionally, TCLP analysis indicates that surface soils, subsurface soil, and sediments at the site do not exhibit hazardous waste characteristics. Therefore, RCRA closure and post-closure requirements and the Treatment Surface Impoundment Exemption (35 IAC 728.104) do not apply.

GAC
granulated activated
carbon

Granulated activated carbon (GAC) treatment of excess stormwater will be performed prior to discharge to the Granite City POTW. Since GAC treatment is a proven technology for the removal of



6. Detailed Analysis of Alternatives

organics, the POTW influent requirements and the associated ARAR will be met. The removal design will incorporate measures to minimize dust generation. Therefore, the dust suppression ARAR will be met. Finally, landfarming has been proven effective in reducing COPC concentrations to less than or equal to concentrations associated with a 10^{-5} risk level. Since the risk-based objectives are lower than TACO's CUOs, TACO requirements also will be met.

Bench- and pilot-scale testing would be needed to fully evaluate the effectiveness and implementability of this alternative. Performance of the landfarm would be evaluated by collecting soil samples on a quarterly basis. A soil sample would be collected for every 1,000 cubic yards of soil, and the samples would be analyzed for the constituents listed in Table 4-1, as well as TCLP analytes. In the event that biodegradation is determined to have been exhausted, established CUOs cannot be achieved, and/or in the unlikely situation that the material would be considered a characteristic hazardous waste, soils exceeding CUOs would be removed from the landfarm and shipped off site for disposal. Further evaluation of the landfarm is presented in Table 6-1. The present worth estimated cost for this alternative is \$3,540,000, which assumes that off-site disposal of soil will not be required. Details of this cost estimate are presented in Table 6-3. Refer to Appendix L for costing documentation.

6.2.3 Alternative S&W3: Low-Temperature Thermal Desorption

In this alternative, contaminated soils and wastes would be excavated and stockpiled. A mobile LTTD unit would be assembled on site and the stockpiled material would be treated. After treatment, the material would be graded across the site and vegetated.

As with the previous alternative, confirmation sampling will be conducted in the open excavation to identify the potential for in situ soil to be a potential source of a characteristic hazardous waste. It should be noted that no listed hazardous waste will be treated by the LTTD process. Since EPA's RCRA guidance states that a contaminated medium that exhibits characteristics of a hazardous waste may not be considered a hazardous waste until it is excavated, RCRA closure and post-closure requirements and the Treatment Surface Impoundment Exemption (35 IAC 728.104) do not apply. The LTTD may generate residuals that are characteristic hazardous waste. Waste determination testing of the residuals will be performed to ensure that appropriate transportation, manifesting, and disposal at a properly licensed facility is provided. Therefore, the waste disposal ARARs will be met.

6. Detailed Analysis of Alternatives

The use of LTDD is widespread, and the technology is becoming mature. Vendors understand the limitations of their process equipment and the needs for pollution control of the off-gas. Therefore, obtaining the appropriate air permits with the necessary pollution-control equipment will be relatively straightforward. By stating the air discharge requirements in the removal design, the technology will be incorporated upfront, and the applicable air permits can be obtained, thereby meeting the air ARARs. The removal design also will incorporate measures to minimize dust generation. Therefore, the dust suppression ARAR will be met.

Finally, LTDD has been proven effective in reducing COPC concentrations to less than or equal to concentrations associated with a 10^{-5} risk level. As with the previous alternative, the risk-based objectives are lower than TACO's CUOs, and the TACO requirements will be met.

With LTDD, COPC concentrations would be reduced, and CUOs would be attained. This alternative would include the treatment and off-site disposal of process residuals as a hazardous waste. Also, there is concern over potential air releases during treatment. The public may oppose this technology, viewing it as similar to incineration. Further evaluation of this alternative is presented in Table 6-1. The present worth estimated cost for this alternative is \$15,680,000. Details of this cost estimate are presented in Table 6-4. Refer to Appendix L for costing documentation.

6.2.4 Alternative S&W4: Off-Site Disposal

In this alternative, contaminated soils and wastes would be excavated and loaded into dump trucks. The trucks would transport the wastes to an off-site TSD facility for disposal as a hazardous waste (F032 or F034).

By excavating all soils with COPC concentrations above the 10^{-5} risk-based concentrations, which are lower than TACO's CUOs, the TACO requirements will have been met. Confirmation sampling will be performed to ensure compliance with the risk-based cleanup objectives. As previously stated, if the confirmation sampling results indicate that in-place soil exhibits a characteristic of a hazardous waste, the soil would not be considered to be a hazardous waste until it is excavated. Therefore, RCRA closure and post-closure requirements are not applicable.

The removal design will specify the necessary requirements associated with selecting an off-site disposal facility, and transportation with the appropriate shipping documents. Therefore, ARARs associated with hazardous waste shipping and disposal will be met. As with all of the "action" alternatives, protocols associated with minimizing dust generation will be

6. Detailed Analysis of Alternatives

incorporated in the removal design to ensure satisfying the appropriate ARARs.

With off-site disposal of the contaminated site soils and wastes, the sources of groundwater contamination would be effectively removed. The toxicity of the soils and wastes would not be reduced, however, because the material would only be transferred to a new locale. Further evaluation of this alternative is presented in Table 6-1. The present worth estimated cost for this alternative is \$14,870,000. Details of this cost estimate are presented in Table 6-5. Refer to Appendix L for costing documentation.

6.2.5 Comparative Evaluation of Soil and Waste Alternatives

All four alternatives are protective of human health and the environment. Least protective is the 24-inch permeable soil cover, which would only cover the contaminated soils and wastes with clean fill material and would allow COPCs to continue to migrate to groundwater. Most protective would be landfarming and LTDD because they include treatment of the contaminated soils and wastes. Off-site disposal, while protective of human health with regard to the surrounding residents, would not reduce the concentrations of COPCs present in the soils and wastes. Rather, the soils and wastes would only be moved to another locale.

All four soil and waste alternatives can be implemented to meet the ARARs with the exception of alternative S&W1, 24-inch permeable soil cover. Since the cover is permeable, stormwater will continue to infiltrate into the contaminated media, causing contaminants to leach into the groundwater.

The key advantage of the 24-inch permeable cover would be the ease and speed of its construction. If this alternative were implemented, the site would be ready for redevelopment sooner than it would be if any of the other three alternatives was implemented. The main disadvantage to this alternative would be that soils and wastes containing COPCs above CUOs would remain in place without treatment or disposal. Because of the high levels of contamination present, and the risks this contamination poses to human health and the environment, construction of a cover would provide only limited protection to human health and the environment.

Off-site disposal of the soils and wastes would reduce the risks to human health and the environment posed by the JW site, but would only transfer the contamination present to a more controlled location in another locale. The contamination would still continue to exist. Off-site disposal is typically a favorable option for limited volumes of soil (i.e., less than 1,000 cubic yards). Still, there

6. Detailed Analysis of Alternatives

would be disposal capacity for the large volume of contaminated soils and wastes at the JW site (approximately 55,000 cubic yards). The cost associated with transporting and disposing of this material eliminates this alternative from consideration.

The two remaining alternatives, landfarming and LTTD, both are preferred over a soil cover and off-site disposal because the soil and waste materials would be treated to reduce the volume, toxicity, and mobility of the COPCs present. Both would take approximately five years to treat the contaminated soils and wastes. The main advantage of LTTD over landfarming is that LTTD can typically achieve lower concentrations of COPCs in the final treated material. This means that LTTD provides more assurance of achieving CUOs than does landfarming. In the event that biodegradation within the landfarm has been exhausted and CUOs cannot be met, soils exceeding the CUOs would be removed from the landfarm and shipped off site for disposal. LTTD does have its disadvantages, chief among them being its cost, which is roughly five times that of a landfarm. Another disadvantage is that LTTD has the potential for community concern and opposition because the technology may be viewed as similar to incineration. LTTD would be implementable, with mobile units available.

Landfarming has been used successfully to treat soils and wastes at other wood-treater sites in Illinois and across the nation. It is a relatively simple and easily implementable technology that would achieve ARARs and likely CUOs. Landfarming would be protective of human health and the environment by reducing the toxicity and mobility of COPCs present in the soils and wastes.

6.3 Non-Aqueous-Phase Liquids

This section evaluates the removal action alternatives that were developed for the removal of NAPLs that are present in the vicinity of the 22nd Street lagoon. The evaluation presented in this section highlights the most significant elements of effectiveness and implementability. Further evaluation of the NAPL alternatives is presented in Table 6-6.

6.3.1 Alternative NAPL1: Hot Water and Steam Flushing

In this alternative, water and steam would be injected into the subsurface to mobilize the NAPLs present in the 22nd Street lagoon area, and flush the NAPLs toward extraction wells for removal. Extracted liquids would be treated by removing the NAPL using an oil/water separator and reinjecting the groundwater. Any excess groundwater would be treated by either granular activated carbon or an ex situ biodegradation process.

The use of steam injection will increase the mobility of the NAPL and facilitate its removal as part of the comprehensive long-term

6. Detailed Analysis of Alternatives

groundwater treatment system. NAPL removal is an essential part of meeting the ARARs associated with groundwater. While steam injection alone will not cause the ARARs to be met, its use is necessary in order to meet the ARARs.

The use of steam injection and the reinjection of treated groundwater will require a permit from IEPA's UIC program. The removal design can incorporate the necessary design parameters to ensure that the technology is implemented in such a manner that a permit can be obtained, and the ARARs can be met. Excess treated groundwater water can be further treated by GAC to ensure compliance with the POTW requirements, thereby meeting the discharge ARARs.

The removal design will require the collected NAPL to undergo a waste determination analysis to ensure that is properly classified. Once properly classified, the appropriate transportation, manifesting, and disposal can be determined, ensuring that waste disposal ARARs are met.

The CROW process, which uses hot water and steam to displace NAPLs, has been used to remove NAPLs at other wood-treater sites. Based on discussions with WRI, the CROW process vendor, this technology appears implementable in the 22nd Street lagoon area. Further evaluation of the CROW process is presented in Table 6-6. The present worth cost estimate for this alternative is \$3,570,000. Details of this cost estimate are presented in Table 6-7. Refer to Appendix L for costing documentation.

6.3.2 Alternative NAPL2: Surfactant Flushing

In this alternative, a surfactant would be injected into the subsurface to mobilize the NAPLs present, and flush the NAPLs toward extraction wells for removal. Extracted liquids would be treated in a similar fashion as Alternative NAPL1.

For surfactant flushing, the ARAR discussion is identical to that of the previous alternative.

Surfactant flushing is still considered an unproven technology because it has not been implemented on a full-scale basis yet at any site. One reason for this is that the selection of a surfactant is a difficult process, with upwards of 100 surfactants typically being evaluated for a NAPL site. Further evaluation of surfactant flushing is presented in Table 6-6. The present worth cost estimate for this alternative is \$3,930,000. Details of this cost estimate are presented in Table 6-8. Refer to Appendix L for cost documentation.

6. Detailed Analysis of Alternatives

6.3.3 Comparative Evaluation of NAPL Removal Alternatives

Hot water and steam flushing (the CROW process) and surfactant flushing differ primarily in the fluid used to displace the NAPLs (i.e., either water or surfactant). At the current time, the use of surfactants to displace NAPLs is still an emerging and unproven technology which is several years away from full-scale implementation. The selection of a surfactant requires extensive bench- and pilot-scale testing. The CROW process has been used successfully at other wood-treating sites. Based on preliminary discussions with WRI, there is a good probability of successful NAPL removal at the JW site with this technology. Both technologies have the potential to effectively remove NAPLs. While NAPL removal alone will not meet ARARs associated with groundwater, groundwater ARARs cannot be met without them. Removal design documents can be developed to ensure that the extracted NAPL is characterized and disposed of properly to ensure compliance with the ARARs. Surfactant flushing would be more expensive to implement at the JW site than the CROW process.

6.4 Groundwater

This section evaluates the removal action alternatives that were developed for the treatment of the 22nd Street lagoon plume and the PCP process area plume. The evaluation presented in this section highlights the most significant elements of effectiveness and implementability relative to these alternatives. Further evaluation of the groundwater alternatives is presented in Table 6-9.

The following alternative evaluations relate only to the 22nd Street lagoon plume and the PCP process area plume. Due to the relatively low concentrations of COPCs in groundwater in the other areas of the site, and because the sources of this relatively low-level groundwater contamination would be removed under one of the soil and waste alternatives (with the exception of the soil cover alternative), the other areas of groundwater contamination should be allowed to naturally attenuate.

6.4.1 Alternative GW1: Natural Attenuation

In this alternative, naturally occurring biodegradation would be allowed to continue without enhancement. Periodic groundwater monitoring would be required to evaluate the progress of the natural cleanup.

Because the subsurface conditions would not be enhanced in this alternative, the natural microbial degradation of COPCs, may slow or cease completely. Therefore, the effectiveness of this alternative to meet groundwater ARARs is uncertain. Also, the IEPA may not

6. Detailed Analysis of Alternatives

agree to establish a GMZ at a site where active groundwater contamination is not occurring. Further evaluation of this alternative is present in Table 6-9. The present worth cost estimate for this alternative is \$1,810,000. Details of this cost estimate are presented in Table 6-10. Refer to Appendix L for costing documentation.

6.4.2 Alternative GW2: Enhanced In Situ Bioremediation

In this alternative, naturally occurring biodegradation within the 22nd Street lagoon and the PCP process area plumes would be enhanced through the addition of oxygen and nutrients to the subsurface. Periodic groundwater monitoring also would be required to evaluate the progress of the enhanced cleanup.

The addition of ORC and nutrients to stimulate biodegradation of COPCs would require a permit from IEPA's UIC program. Since an increase in the nutrient and oxygen levels in the groundwater would be beneficial, obtaining a permit should not be difficult. The biological degradation process will meet the risk-based cleanup objectives, thereby meeting the ARARs associated with groundwater.

In situ enhanced bioremediation would provide protection of human health and the environment by reducing the concentrations of COPCs in groundwater. Additional bench- and pilot-scale testing would be required to fully evaluate the effectiveness and implementability of this alternative. Further evaluation of this alternative is presented in Table 6-9. The present worth cost estimate for this alternative is \$2,660,000. Details of this cost estimate are presented in Table 6-11. Refer to Appendix L for costing documentation.

6.4.3 Alternative GW3: Ex Situ Biological Treatment

In this alternative, contaminated groundwater from the 22nd Street lagoon plume and the PCP process area plume would be removed from the subsurface through the use of strategically placed extraction wells. Removed groundwater would be treated in an on-site biological treatment system. Treated groundwater would be reinjected into the subsurface or discharged to the Granite City sanitary sewer system. Periodic groundwater monitoring would also be required to evaluate the progress of the cleanup.

Ex situ biological treatment of contaminated groundwater would achieve ARARs and can be designed to ensure compliance with the local POTW requirements. Of the three groundwater alternatives, it would also achieve CUOs in the shortest amount of time. This alternative is complex, however, and would require extensive bench- and pilot-scale testing during the design phase.

6. Detailed Analysis of Alternatives

Implementation of this alternative would include the construction of a new treatment building on site. Treated effluent from the system would need to be managed. Further evaluation of this alternative is presented in Table 6-9. The present worth cost estimate for this alternative is \$3,080,000. Details of this cost estimate are presented in Table 6-12. Refer to Appendix L for cost documentation.

6.4.4 Comparative Evaluation of Groundwater Alternatives

All three groundwater alternatives consist of varying levels of bioremediation. Natural attenuation would be the least costly groundwater alternative to implement, with periodic groundwater monitoring being the main cost item. No construction would be involved. IEPA approval of a GMZ for a site not undergoing active groundwater remediation is questionable. Based on the high concentrations of COPCs found in site groundwater during EE/CA support sampling, natural attenuation, while likely occurring at a slow rate, is not appreciably reducing the concentrations of COPCs in groundwater and may not ever meet the ARARs and associated cleanup objectives. A more aggressive groundwater cleanup approach would likely be needed to reduce COPC concentrations to CUOs.

The remaining two groundwater alternatives would meet the ARARs associated with COPC contaminant levels in a reasonable time frame. Both alternatives can be design to ensure compliance with all ARARs.

Enhanced in situ bioremediation takes natural attenuation one step further through the addition of oxygen and nutrients to the subsurface to enhance the rate of naturally occurring biodegradation. It would effectively reduce the concentrations of COPCs in groundwater. This alternative would be relatively easy to implement. Enhanced in situ bioremediation would be more costly than natural attenuation, but much less costly than the third groundwater alternative, ex situ biological treatment. Enhanced in situ bioremediation would entail a moderate level of PRSC in the form of ORC sock changeout in the PCP process area, and the maintenance of air sparging equipment in the 22nd Street lagoon area.

Ex situ biological treatment is the most aggressive of the three groundwater cleanup alternatives. If implemented, this alternative would achieve groundwater CUOs in the shortest period of time. Disadvantages of this alternative include its high cost and its relatively difficult design, construction, and PRSC.

6. Detailed Analysis of Alternatives

6.5 Buildings

An essential component of all of the soil removal alternatives is the demolition and removal of site buildings and their foundations. In order for the selected soil alternative to address site-wide soil contamination, the buildings and foundations must be removed to provide access to the contaminated soil. If the buildings and foundations are not removed, contaminated soil still will be present on site after the completion of the removal action. It also should be noted that the buildings are either structurally unsound and/or contain RACM.

While each soil alternative has a cost item for the removal and disposal of debris piles and miscellaneous concrete pads located throughout the site, the building demolition and foundation removal was separated from the soil alternatives to clarify the cost estimates. A cost estimate for this work is presented in Table 6-13. Refer to Appendix L for costing documentation.

6.6 Miscellaneous Items

Like the site buildings, the miscellaneous items discussed in Section 5 are an integral component of the soil removal alternatives. The miscellaneous items either are contaminated and/or contain waste materials. If these items are not addressed as part of the soil alternatives, contaminated soils beneath the structures will remain in place after implementation of the soil removal alternative. Since the majority of these items contain waste, if they are not removed from the site, there will always be the potential for the waste to leak out or the vessel to rupture, thereby contaminating remediated soils. Therefore, these items should be removed from the site.

Like the site buildings, the cost associated with removing the miscellaneous items was separated from the soil alternatives for the purposes of clarifying the cost estimates. Therefore, these items should be removed from the site as discussed in Section 5. A cost estimate for this work is presented in Table 6-14. Refer to Appendix L for costing documentation.

Table 6-1

**ALTERNATIVE EVALUATIONS FOR SOILS AND WASTES
JENNISON-WRIGHT SITE
GRANITE CITY, ILLINOIS**

Alternative Number	Alternative	Effectiveness	Implementability	Cost
S&W1	24-Inch Permeable Cover	<p>Provides human health protection by preventing direct contact through covering contaminated soils.</p> <p>Contamination would remain in place. Toxicity, mobility, and volume would not be reduced.</p> <p>Contaminated soils and waste would continue to act as a source of groundwater contamination.</p>	<p>Cover construction is an established construction procedure.</p> <p>Future use of the site would not disturb cover material. Deed restrictions would be required.</p> <p>Materials and services readily available.</p>	<p>Capital: \$1,570,000 Annual PRSC: \$32,000 Total Present Worth: \$2,060,000</p>
S&W2	Landfarm	<p>Provides protection by reducing concentrations of COPCs. Would achieve ARARs.</p> <p>Requires lengthy operation (6 years).</p> <p>Reduces toxicity and mobility of COPCs through degradation. Due to the addition of bulking agents, volume would not be reduced.</p> <p>Poses potential risks to workers and community from air releases during excavation and treatment. Air monitoring would be required.</p>	<p>Simple technology—relatively easy to construct and operate.</p> <p>Microbial degradation is affected by a multitude of factors. Bench- and pilot-scale studies would be needed.</p> <p>Stormwater would need to be treated and discharged to sewer. A fee would be assessed.</p>	<p>Capital: \$1,780,000 Annual PRSC: \$407,000 Total Present Worth: \$3,540,000</p>

Table 6-1

**ALTERNATIVE EVALUATIONS FOR SOILS AND WASTES
JENNISON-WRIGHT SITE
GRANITE CITY, ILLINOIS**

Alternative Number	Alternative	Effectiveness	Implementability	Cost
S&W3	Low-Temperature Thermal Desorption	<p>Would include treatment and off-site disposal of residuals as hazardous waste.</p> <p>Significantly reduces toxicity, mobility, and volume of COPCs through treatment.</p> <p>Poses potential risks to workers and community from air releases during excavation and treatment. Air monitoring would be required.</p>	<p>Substantive permit requirements must be addressed.</p> <p>Mobile LTDD units are readily available.</p> <p>Public may oppose technology, viewing it as similar to incineration.</p>	<p>Capital: \$445,000 Annual PRSC: \$3,518,000 Total Present Worth: \$15,680,000</p>
S&W4	Off-Site Disposal	<p>Effective removal of source materials.</p> <p>By removing soils and wastes from the site, a reduction in on-site toxicity, mobility, and volume is achieved. However, wastes are only transferred to a new locale.</p> <p>Poses potential risks to workers and community from air releases during excavation. Air monitoring would be required.</p> <p>Reduction of threat to groundwater.</p>	<p>Technically and administratively feasible.</p> <p>Disposal capacity available.</p> <p>Public may oppose increased truck traffic through Granite City.</p>	<p>Capital: \$14,870,000 Annual PRSC: \$0 Total Present Worth: \$14,870,000</p>

Note: Total present worth costs rounded to the nearest \$10,000.

Key:

COPC = Chemical of potential concern.

PRSC = Post-removal site control.

S&W = Soils and wastes.

LTDD = Low-temperature thermal desorption.

ARAR

= Applicable or Relevant and Appropriate Requirement.

Table 6-2

REMOVAL ACTION COST ANALYSIS - ALTERNATIVE S&W1
24-INCH PERMEABLE SOIL COVER
ENGINEERING EVALUATION/COST ANALYSIS
JENNISON-WRIGHT
GRANITE CITY, ILLINOIS

Direct Capital Costs				
Item Description	Quantity	Unit	Cost/Unit	Cost
Field Overhead and Oversight	6	month	\$14,646	\$87,876
Health and Safety	6	month	\$12,887	\$77,322
Mobilization and Demobilization of Site Equipment	1	lump sum	\$9,470	\$9,470
Decontamination Pad	1-	lump sum	\$12,799	\$12,799
Base Preparation (Clearing and Grubbing)	16.6	acre	\$1,000	\$16,600
General Area Cleanup, Removal of Debris	16.6	acre	\$301	\$4,997
Classified Permeable Fill	53,570	cubic yard	\$8.75	\$468,738
Colored Fabric	723,100	square ft	\$0.19	\$137,389
Place and Compact Fill	53,570	cubic yard	\$1.75	\$93,748
Seed and Fertilize	16.6	acre	\$1,500	\$24,900
Subtotal Direct Capital Costs				\$933,839
Overhead and Profit (25%)				\$233,460
<i>Total Direct Capital Costs (Rounded to Nearest \$1,000)</i>				\$1,167,000
Indirect Capital Costs				
Engineering and Design (7%)				\$81,690
Legal Fees and License/Permit Costs (5%)				\$58,350
Construction Oversight (5%)				\$58,350
<i>Total Indirect Capital Costs (Rounded to Nearest \$1,000)</i>				\$198,000
Subtotal Capital Costs				\$1,365,000
Contingency Allowance (15%)				\$204,750
<i>Total Capital Costs (Rounded to Nearest 1,000)</i>				\$1,570,000
Annual PRSC Costs				
Item Description	Quantity	Unit	Cost/Unit	Cost
Cover Maintenance	1	lump sum	\$16,136	\$16,136
Yearly Summary Report/Cover Inspection	1	lump sum	\$5,326	\$5,326
<i>Subtotal Direct PRSC Costs (Rounded to Nearest \$1,000)</i>				\$21,000
Indirect PRSC Costs				
Overhead and Profit (25%)				\$5,250
Administration (5%)				\$1,050
Insurance, Taxes, Licenses (2.5%)				\$525
<i>Subtotal Indirect PRSC Costs</i>				\$6,825
<i>Subtotal Direct and Indirect PRSC Costs (Rounded to Nearest \$1,000)</i>				\$28,000
Contingency Allowance (15%)				\$4,200
<i>Total Annual PRSC Cost (Rounded to the nearest \$1,000)</i>				\$32,000

30 Year Cost Projection (Assumed discount rate per year: 5%)	
Total Capital Costs	\$1,570,000
Present Worth of 30 years PRSC (Rounded to Nearest \$1,000)	\$492,000
Total Alternative Cost (Rounded to Nearest \$10,000)	\$2,060,000

Table 6-3

**REMOVAL ACTION COST ANALYSIS - ALTERNATIVE S&W2
LANDFARM
ENGINEERING EVALUATION/COST ANALYSIS
JENNISON-WRIGHT
GRANITE CITY, ILLINOIS**

Direct Capital Costs				
Item Description	Quantity	Unit	Cost/Unit	Cost
Field Overhead and Oversight	6	month	\$14,646	\$87,876
Health and Safety	6	month	\$12,887	\$77,322
Mobilization and Demobilization of Site Equipment	1	lump sum	\$9,470	\$9,470
Decontamination Pad	1	lump sum	\$12,799	\$12,799
Removal and Disposal of Concrete and Debris	1	lump sum	\$154,456	\$154,456
Storage Shed	1	each	\$13,643	\$13,643
Construction of Landfarm Cell, (550' x 550')	1	lump sum	\$575,303	\$575,303
Construction of Ramp	1	each	\$1,812	\$1,812
Temporary Stockpile Pad and Cover (100' X 100')	1	lump sum	\$27,754	\$27,754
Drainage Collection and Treatment	1	lump sum	\$25,927	\$25,927
Construction of Retention Pond (1 million gallons, 5 foot deep)	1	lump sum	\$72,093	\$72,093
Subtotal Direct Capital Costs				\$1,058,455
Overhead and Profit (25%)				\$264,614
Subtotal Direct Capital Costs (Rounded to Nearest \$1,000)				\$1,323,000
Indirect Capital Costs				
Engineering and Design (7%)				\$92,610
Legal Fees and License/Permit Costs (5%)				\$66,150
Construction Oversight (5%)				\$66,150
Subtotal Indirect Capital Costs (Rounded to Nearest \$1,000)				\$225,000
Subtotal Capital Costs				\$1,548,000
Contingency Allowance (15%)				\$232,200
Total Capital Costs (Rounded to Nearest 1,000)				\$1,780,000
Annual PRSC Costs				
Item Description	Quantity	Unit	Cost/Unit	Cost
Excavation and Transportation of Impacted Soil	11,000	cubic yard	\$7.52	\$82,720
Confirmation Soil Sample Collection and Analysis (Excavations)	30	each	\$350.00	\$10,500
Backfill Material for Deep Excavations	2,100	cubic yard	\$7.00	\$14,700
Backfill and Compact Treated Soil and Deep Excavation Fill	13,100	cubic yard	\$1.40	\$18,340
Seed and Fertilize	2.8	acre	\$1,500	\$4,200
Soil Tilling, Nutrient and Water Addition	4	quarter	\$9,575	\$38,300
Confirmation Soil Sample Collection and Analysis (landfarm)	4	quarter	\$12,974	\$51,896
Air Monitoring	12	month	\$3,094	\$37,128
On-Site Carbon Treatment	1,002	1,000 gal	\$0.55	\$551
Disposal of Treated Retention Pond Water to Sanitary Sewer	1,340	100 cf	\$0.86	\$1,152
Yearly Summary Report	1	lump sum	\$7,392	\$7,392
Subtotal Direct PRSC Costs (Rounded to Nearest \$1,000)				\$267,000
Overhead and Profit (25%)				\$66,750
Administration (5%)				\$13,350
Insurance, Taxes, Licenses (2.5%)				\$6,675
Subtotal Indirect PRSC Costs (Rounded to Nearest \$1,000)				\$87,000
Subtotal Direct and Indirect PRSC Costs (Rounded to Nearest \$1,000)				\$354,000
Contingency Allowance (15%)				\$53,100
Total Annual PRSC Cost (Rounded to the nearest \$1,000)				\$407,000

5 Year Cost Projection (Assumed discount rate per year: 5%)	
Total Capital Costs	\$1,780,000
Present Worth of 5 years PRSC (Rounded to Nearest \$1,000)	\$1,762,000
Total Alternative Cost (Rounded to Nearest \$10,000)	\$3,540,000

Table 6-4

**REMOVAL ACTION COST ANALYSIS - ALTERNATIVE S&W3
LOW TEMPERATURE THERMAL DESORPTION
ENGINEERING EVALUATION/COST ANALYSIS
JENNISON-WRIGHT
GRANITE CITY, ILLINOIS**

Direct Capital Costs				
Item Description	Quantity	Unit	Cost/Unit	Cost
Field Overhead and Oversight	1	month	\$14,646	\$14,646
Health and Safety	1	month	\$12,887	\$12,887
Mobilization and Demobilization of Site Equipment	1	lump sum	\$9,470	\$9,470
Decontamination Pad	1	each	\$12,799	\$12,799
Storage Shed	1	each	\$13,643	\$13,643
Removal and Disposal of Concrete and Debris	1	lump sum	\$154,456	\$154,456
Temporary Stockpile Pad and Cover (100' X 100')	1	lump sum	\$27,754	\$27,754
Move/Demove Mobile LTDD Unit	1	lump sum	\$17,215	\$17,215
Decon Mobile LTDD Unit	1	each	\$2,000	\$2,000
Subtotal Direct Capital Costs				\$264,870
Overhead and Profit (25%)				\$66,218
Total Direct Capital Costs (Rounded to Nearest \$1,000)				\$331,000
Indirect Capital Costs				
Engineering and Design (7%)				\$23,170
Legal Fees and License/Permit Costs (5%)				\$16,550
Construction Oversight (5%)				\$16,550
Total Indirect Capital Costs (Rounded to Nearest \$1,000)				\$56,000
Subtotal Capital Costs				\$387,000
Contingency Allowance (15%)				\$58,050
Total Capital Costs (Rounded to Nearest 1,000)				\$445,000
Annual PRSC Costs				
Item Description	Quantity	Unit	Cost/Unit	Cost
Excavation of Impacted Soil and Transport to LTDD Unit	11,000	cubic yard	\$7.52	\$82,720
Mobile LTDD Unit Process Soil to CUOs	17,820	ton	\$116	\$2,067,120
Confirmation Soil Sample Collection and Analysis (Excavation)	30	each	\$350	\$10,500
Confirmation Soil Sample Collection and Analysis (LTDD Process)	52	each	\$866	\$45,032
Air Monitoring	12.0	month	\$3,094	\$37,128
Transportation to Disposal Facility	356	ton	\$28.40	\$10,110
Permitting an Analytical	1	each	\$500	\$500
Off-Site Disposal of Soils and Waste (RCRA Direct Disposal)	356	ton	\$80	\$28,480
Backfill and Compact Treated Soil	11,000	cubic yard	\$1.40	\$15,400
Seed and Fertilize	3	acre	\$1,500	\$4,200
Yearly Summary Report	1	lump sum	\$7,392	\$7,392
Subtotal Direct PRSC Costs (Rounded to Nearest \$1,000)				\$2,309,000
Overhead and Profit (25%)				\$577,250
Administration (5%)				\$115,450
Insurance, Taxes, Licenses (2.5%)				\$57,725
Subtotal Indirect PRSC Costs (Rounded to Nearest \$1,000)				\$750,000
Subtotal Direct and Indirect PRSC Costs (Rounded to Nearest \$1,000)				\$3,059,000
Contingency Allowance (15%)				\$458,850
Total Annual PRSC Cost (Rounded to the nearest \$1,000)				\$3,518,000
5 Year Cost Projection (Assumed discount rate per year: 5%)				
Total Capital Costs				\$445,000
Present Worth of 5 years PRSC (Rounded to Nearest \$1,000)				\$15,231,000
Total Alternative Cost (Rounded to Nearest \$10,000)				\$15,680,000

Table 6-5

**REMOVAL ACTION COST ANALYSIS - ALTERNATIVE S&W4
OFF-SITE DISPOSAL
ENGINEERING EVALUATION/COST ANALYSIS
JENNISON-WRIGHT
GRANITE CITY, ILLINOIS**

Direct Capital Costs				
Item Description	Quantity	Unit	Cost/Unit	Cost
Field Overhead and Oversight	7	month	\$14,646	\$102,522
Health and Safety	7	month	\$12,887	\$90,209
Mobilization and Demobilization of Site Equipment	1	lump sum	\$9,470	\$9,470
Air Monitoring	7	month	\$3,094	\$21,658
Decontamination Pad	1	lump sum	\$12,799	\$12,799
Excavation and On-Site Hauling	55,100	cubic yard	\$7.52	\$414,352
Transportation to Disposal Facility	90,000	ton	\$22.72	\$2,044,800
Confirmation Soil Samples and Analysis	150	each	\$350.00	\$52,500
Removal and Disposal of Concrete and Debris	1	lump sum	\$154,456	\$154,456
Permitting and Analytical	5	each	\$500	\$2,500
Off-Site Disposal of Soils and Waste (RCRA Direct Disposal)	90,000	ton	\$64	\$5,760,000
Seed and Fertilize	16.6	acre	\$1,500	\$24,900
Backfill Material	55,100	cubic yard	\$7.00	\$385,700
Backfill and Compact	55,100	cubic yard	\$1.40	\$77,140
Subtotal Direct Capital Costs				\$9,153,006
Overhead and Profit (25%)				\$2,288,252
<i>Total Direct Capital Costs (Rounded to Nearest \$1,000)</i>				\$11,441,000
Indirect Capital Costs				
Engineering and Design (3%)				\$343,230
Legal Fees and License/Permit Costs (5%)				\$572,050
Construction Oversight (5%)				\$572,050
<i>Total Indirect Capital Costs (Rounded to Nearest \$1,000)</i>				\$1,487,000
Subtotal Capital Costs				\$12,928,000
Contingency Allowance (15%)				\$1,939,200
Total Alternative Cost (Rounded to Nearest 10,000)				\$14,870,000

Table 6-6
ALTERNATIVE EVALUATIONS FOR NAPL REMOVAL
JENNISON-WRIGHT SITE
GRANITE CITY, ILLINOIS

Alternative Number	Alternative	Effectiveness	Implementability	Cost
NAPL1	Hot Water and Steam Flushing	<p>Depth of NAPL (115 feet BGS) makes complete removal, by any technology, difficult or impossible.</p> <p>Technology has been tested and proven at other sites.</p> <p>Recovered NAPL would require off-site disposal.</p> <p>Potential short-term risks to workers from handling and transporting recovered NAPLs.</p>	<p>The CROW process is patented. A fee would need to be paid to the patent holder. An agreement would need to be signed with the vendor.</p> <p>Obtaining approval from regulatory agencies for the reinjection of recovered groundwater would be time-consuming.</p> <p>Drilling of the required injection and extraction wells would be a lengthy and costly task.</p> <p>The CROW process requires no specialized or hard-to-find equipment.</p>	<p>Capital: \$1,448,000 Annual PRSC: \$597,000 Total Present Worth: \$3,570,000</p>
NAPL2	Surfactant Flushing	<p>Depth of NAPL (115 feet BGS) makes complete removal, by any technology, difficult or impossible.</p> <p>Technology has not been proven on a full-scale basis.</p> <p>Recovered NAPL would require off-site disposal.</p> <p>Potential short-term risks to workers from handling and transporting recovered NAPLs.</p>	<p>Obtaining approval from regulatory agencies for the injection of surfactant would be difficult.</p> <p>No full-scale implementation of this technology is known.</p> <p>Selection of a surfactant requires extensive bench- and pilot-scale testing.</p>	<p>Capital: \$1,566,000 Annual PRSC: \$666,000 Total Present Worth: \$3,930,000</p>

Note: Total present worth costs rounded to nearest \$10,000.

Key: BGS = Below ground surface.
PRSC = Post-removal site control.
NAPL = Non-aqueous-phase liquid.
CROW = Contained Recovery of Oily Waste.

Table 6-7

REMOVAL ACTION COST ANALYSIS - ALTERNATIVE NAPL1
HOT WATER AND STEAM FLUSHING
ENGINEERING EVALUATION/COST ANALYSIS
JENNISON-WRIGHT
GRANITE CITY, ILLINOIS

Direct Capital Costs				
Item Description	Quantity	Unit	Cost/Unit	Cost
Field Overhead and Oversight	3	month	\$14,646	\$43,938
Health and Safety	3	month	\$12,887	\$38,661
Mobilization and Demobilization	1	lump sum	\$8,500	\$8,500
Storage Shed	1	each	\$13,643	\$13,643
Additional NAPL Investigation	1	lump sum	\$65,185	\$65,185
Pilot Scale, Field Study CROW System	1	lump sum	\$32,000	\$32,000
Review of CROW System Design (WRI)	1	lump sum	\$18,720	\$18,720
Construction of Treatment System	1	lump sum	\$587,840	\$587,840
Dismantling of Treatment System	1	lump sum	\$52,320	\$52,320
Subtotal Direct Capital Costs				\$860,807
Overhead and Profit (25%)				\$215,202
Total Direct Capital Costs (Rounded to Nearest \$1,000)				\$1,076,000
Indirect Capital Costs				
Engineering and Design (7%)				\$75,320
Legal Fees and License/Permit Costs (5%)				\$53,800
Construction Oversight (5%)				\$53,800
Total Indirect Capital Costs (Rounded to Nearest \$1,000)				\$183,000
Subtotal Capital Costs				\$1,259,000
Contingency Allowance (15%)				\$188,850
Total Capital Costs (Rounded to Nearest 1,000)				\$1,448,000
Annual PRSC Costs				
Item Description	Quantity	Unit	Cost/Unit	Cost
O & M of Treatment System	1	year	\$290,400	\$290,400
Reporting	1	lump sum	\$9,280	\$9,280
On-Site Carbon Treatment	5,260	1000 gal.	\$0.55	\$2,893
Off-Site Disposal of Treated Liquid to Sanitary Sewer	7,030	100 cf	\$0.86	\$6,046
Transportation of NAPL Oil to Incinerator	51,000	gal	\$0.16	\$8,160
Off-Site Disposal of NAPL Oil (Incineration)	446,760	pound	\$0.15	\$67,908
Yearly Summary Report	1	lump sum	\$7,392	\$7,392
Subtotal Direct PRSC Costs (Rounded to Nearest \$1,000)				\$392,000
Overhead and Profit (25%)				\$98,000
Administration (5%)				\$19,600
Insurance, Taxes, Licenses (2.5%)				\$9,800
Subtotal Indirect PRSC Costs (Rounded to Nearest \$1,000)				\$127,000
Subtotal Direct and Indirect PRSC Costs (Rounded to Nearest \$1,000)				\$519,000
Contingency Allowance (15%)				\$77,850
Total Annual PRSC Cost (Rounded to the nearest \$1,000)				\$597,000

4 Year Cost Projection (Assumed discount rate per year: 5%)	
Total Capital Costs	\$1,448,000
Present Worth of 4 years PRSC (Rounded to Nearest \$1,000)	\$2,117,000
Total Alternative Cost (Rounded to Nearest \$10,000)	\$3,570,000

Table 6-8

**REMOVAL ACTION COST ANALYSIS - ALTERNATIVE NAPL2
SURFACTANT FLUSHING
ENGINEERING EVALUATION/COST ANALYSIS
JENNISON-WRIGHT
GRANITE CITY, ILLINOIS**

Direct Capital Costs				
Item Description	Quantity	Unit	Cost/Unit	Cost
Field Overhead and Oversight	3	month	\$14,646	\$43,938
Health and Safety	3	month	\$12,887	\$38,661
Mobilization and Demobilization	1	lump sum	\$8,500	\$8,500
Storage Shed	1	each	\$13,643	\$13,643
Additional NAPL Investigation	1	lump sum	\$65,185	\$65,185
Pilot Scale, Field Study of Surfactant Treatment System	1	lump sum	\$87,800	\$87,800
Design of Surfactant Treatment System	1	lump sum	\$33,680	\$33,680
Construction of Treatment System	1	lump sum	\$587,840	\$587,840
Dismantling of Treatment System	1	lump sum	\$52,320	\$52,320
Subtotal Direct Capital Costs				\$931,567
Overhead and Profit (25%)				\$232,892
Total Direct Capital Costs (Rounded to Nearest \$1,000)				\$1,164,000
Indirect Capital Costs				
Engineering and Design (7%)				\$81,480
Legal Fees and License/Permit Costs (5%)				\$58,200
Construction Oversight (5%)				\$58,200
Total Indirect Capital Costs (Rounded to Nearest \$1,000)				\$198,000
Subtotal Capital Costs				\$1,362,000
Contingency Allowance (15%)				\$204,300
Total Capital Costs (Rounded to Nearest 1,000)				\$1,566,000
Annual PRSC Costs				
Item Description	Quantity	Unit	Cost/Unit	Cost
Surfactant Addition	168,750	pound	\$1.70	\$287,550
O & M of Treatment System	1	lump sum	\$62,938	\$62,938
On-Site Carbon Treatment	5,260	1000 gal	\$0.55	\$2,893
Off-Site Disposal of Treated Liquid to Sanitary Sewer	703	100 ccf	\$0.86	\$605
Transportation of NAPL Oil to Incinerator	51,000	gal	\$0.16	\$8,160
Off-Site Disposal of NAPL Oil (Incineration)	446,760	pound	\$0.15	\$67,908
Yearly Summary Report	1	lump sum	\$7,392	\$7,392
Subtotal Direct PRSC Costs (Rounded to Nearest \$1,000)				\$437,000
Overhead and Profit (25%)				\$109,250
Administration (5%)				\$21,850
Insurance, Taxes, Licenses (2.5%)				\$10,925
Subtotal Indirect PRSC Costs (Rounded to Nearest \$1,000)				\$142,000
Subtotal Direct and Indirect PRSC Costs (Rounded to Nearest \$1,000)				\$579,000
Contingency Allowance (15%)				\$86,850
Total Annual PRSC Cost (Rounded to the nearest \$1,000)				\$666,000
4 Year Cost Projection (Assumed discount rate per year: 5%)				
Total Capital Costs				\$1,566,000
Present Worth of 4 years PRSC (Rounded to Nearest \$1,000)				\$2,362,000
Total Alternative Cost (Rounded to Nearest \$10,000)				\$3,930,000

Table 6-9

**ALTERNATIVE EVALUATIONS FOR GROUNDWATER
JENNISON-WRIGHT SITE
GRANITE CITY, ILLINOIS**

Alternative Number	Alternative	Effectiveness	Implementability	Cost
GW1	Natural Attenuation	<p>Natural microbial degradation of COPCs may slow or cease completely due to inadequate conditions in the subsurface.</p> <p>Existing contamination would require institutional controls.</p> <p>Existing contamination would continue to migrate.</p> <p>Requires very lengthy operation.</p> <p>This process would generate no wastestreams that need to be disposed of.</p>	<p>No specialized or "hard-to-find" equipment required.</p> <p>IEPA may not agree to establish a GMZ at a site where active groundwater remediation is not occurring.</p> <p>Long-term PRSC activities would be required.</p>	<p>Capital: \$0</p> <p>Annual PRSC: \$118,000</p> <p>Total Present Worth: \$1,810,000</p>
GW2	Enhanced In Situ Bioremediation	<p>Provides protection by reducing concentrations of COPCs in groundwater.</p> <p>Requires moderately lengthy operation.</p> <p>Would achieve ARARs. Has a good probability of achieving CUOs.</p> <p>In situ bioremediation requires little subsurface disturbance, and, therefore, presents few short-term risks to workers and nearby residents.</p>	<p>Bench- and pilot-scale testing would be required.</p> <p>Technology is relatively simple to construct, operate, and maintain.</p> <p>Low operator attention required.</p> <p>Dependent on the market price of ORC, which could be problematic in the event of sudden price hikes or future unavailability of the product.</p>	<p>Capital: \$507,000</p> <p>Annual PRSC (Years 1-3): \$150,000</p> <p>Annual PRSC (Years 4-20): \$186,000</p> <p>Total Present Worth: \$2,660,000</p>

Key at end of table.

<p style="text-align: center;">Table 6-9</p> <p style="text-align: center;">ALTERNATIVE EVALUATIONS FOR GROUNDWATER</p> <p style="text-align: center;">JENNISON-WRIGHT SITE</p> <p style="text-align: center;">GRANITE CITY, ILLINOIS</p>				
Alternative Number	Alternative	Effectiveness	Implementability	Cost
GW3	Ex Situ Biological Treatment	<p>Provides protection by reducing concentrations of COPCs in groundwater.</p> <p>Would achieve ARARs and CUOs.</p> <p>This process would generate a final treated effluent which would need to be reinjected to the subsurface or discharged to the sewer system.</p> <p>Ex situ biological treatment presents potential short-term risks to workers who may come into contact with extracted groundwater.</p> <p>Requires relatively short operation.</p>	<p>Complex design and bench- and pilot-scale testing would be required.</p> <p>Technology is moderately difficult to construct and operate.</p> <p>Operator intensive.</p>	<p>Capital: \$1,239,000</p> <p>Annual PRSC: \$239,000</p> <p>Total Present Worth: \$3,080,000</p>

Note: Total present worth costs rounded to nearest \$10,000.

Key:

ARAR = Applicable or Relevant and Appropriate Requirement.
 COPC = Chemical of potential concern.
 CUO = Cleanup objective.
 GMZ = Groundwater management zone.
 GW = Groundwater.
 IEPA = Illinois Environmental Protection Agency.
 ORC = Oxygen-releasing compound.
 PRSC = Post-removal site control.

Table 6-10

REMOVAL ACTION COST ANALYSIS - ALTERNATIVE GW1
NATURAL ATTENUATION
ENGINEERING EVALUATION/COST ANALYSIS
JENNISON-WRIGHT
GRANITE CITY, ILLINOIS

Direct Capital Costs				
Item Description	Quantity	Unit	Cost/Unit	Cost
Groundwater Monitoring	2	round	\$35,190	\$70,380
Yearly Summary Report	1	lump sum	\$7,392	\$7,392
<i>Subtotal Direct PRSC Costs (Rounded to Nearest \$1,000)</i>				\$78,000
Overhead and Profit (25%)				\$19,500
Administration (5%)				\$3,900
Insurance, Taxes, Licenses (2.5%)				\$1,950
<i>Subtotal Indirect PRSC Costs (Rounded to Nearest \$1,000)</i>				\$25,000
<i>Subtotal Direct and Indirect PRSC Costs (Rounded to Nearest \$1,000)</i>				\$103,000
Contingency Allowance (15%)				\$15,450
Total Annual PRSC Cost (Rounded to the nearest \$1,000)				\$118,000

30 Year Cost Projection (Assumed discount rate per year: 5%)	
Total Capital Costs	\$0
Present Worth of 30 years PRSC (Rounded to Nearest \$1,000)	\$1,814,000
Total Alternative Cost (Rounded to Nearest \$10,000)	\$1,810,000

Table 6-11

**REMOVAL ACTION COST ANALYSIS - ALTERNATIVE GW2
ENHANCED IN-SITU BIOREMEDIATION
ENGINEERING EVALUATION/COST ANALYSIS
JENNISON-WRIGHT
GRANITE CITY, ILLINOIS**

Direct Capital Costs				
Item Description	Quantity	Unit	Cost/Unit	Cost
Field Overhead and Oversight	1	month	\$14,646	\$14,646
Health and Safety	1	month	\$12,887	\$12,887
Mobilization and Demobilization	1	lump sum	\$8,500	\$8,500
Bench-Scale Study	1	lump sum	\$8,000	\$8,000
Construction of Air Sparging System and Additional Sparging Points	1	lump sum	\$156,852	\$156,852
Installation of 8 Additional Wells (PCP Area)	1	lump sum	\$42,712	\$42,712
Subtotal Direct Capital Costs				\$243,597
Overhead and Profit (25%)				\$60,899
Total Direct Capital Costs (Rounded to Nearest \$1,000)				\$304,000
Indirect Capital Costs				
Engineering and Design (35%)				\$106,400
Legal Fees and License/Permit Costs (5%)				\$15,200
Construction Oversight (5%)				\$15,200
Total Indirect Capital Costs (Rounded to Nearest \$1,000)				\$137,000
Subtotal Capital Costs				\$441,000
Contingency Allowance (15%)				\$66,150
Total Capital Costs (Rounded to Nearest \$1,000)				\$507,000
Annual PRSC Costs (Years 1 through 3)				
Item Description	Quantity	Unit	Cost/Unit	Cost
Oxygen Releasing Compound (ORC) 2-Inch Sock	800	linear ft	\$24.00	\$19,200
Change Out of ORC Socks (Labor)	40	hour	\$29.81	\$1,192
Groundwater Monitoring	2	round	\$35,190	\$70,380
Yearly Summary Report	1	lump sum	\$7,392	\$7,392
Subtotal Direct PRSC Costs (Rounded to Nearest \$1,000)				\$98,000
Overhead and Profit (25%)				\$24,500
Administration (5%)				\$4,900
Insurance, Taxes, Licenses (2.5%)				\$2,450
Subtotal Indirect PRSC Costs (Rounded to Nearest \$1,000)				\$32,000
Subtotal Direct and Indirect PRSC Costs (Rounded to Nearest \$1,000)				\$130,000
Contingency Allowance (15%)				\$19,500
Total Annual PRSC Costs for Years 1 - 3 (Rounded to the nearest \$1,000)				\$150,000
Annual PRSC Costs (Years 4 through 20)				
Item Description	Quantity	Unit	Cost/Unit	Cost
Oxygen Releasing Compound (ORC) 2-Inch Sock	800	linear ft	\$24.00	\$19,200
Change Out of ORC Socks (Labor)	80	hour	\$29.81	\$2,385
O & M of Air Sparging Treatment System	1	year	\$22,270	\$22,270
Groundwater Monitoring	2	round	\$35,190	\$70,380
Yearly Summary Report	1	lump sum	\$7,392	\$7,392
Subtotal Direct PRSC Costs (Rounded to Nearest \$1,000)				\$122,000
Overhead and Profit (25%)				\$30,500
Administration (5%)				\$6,100
Insurance, Taxes, Licenses (2.5%)				\$3,050
Subtotal Indirect PRSC Costs (Rounded to Nearest \$1,000)				\$40,000
Subtotal Direct and Indirect PRSC Costs (Rounded to Nearest \$1,000)				\$162,000
Contingency Allowance (15%)				\$24,300
Total Annual PRSC Costs for Years 4 - 20 (Rounded to the nearest \$1,000)				\$186,000
20 Year Cost Projection (Assumed discount rate per year: 5%)				
Total Capital Costs				\$507,000
Present Worth of 1 - 3 years PRSC (Rounded to Nearest \$1,000)				\$410,000
Present Worth of 4 - 20 years PRSC (Rounded to Nearest \$1,000)				\$1,741,000
Total Alternative Cost (Rounded to Nearest \$10,000)				\$2,660,000

Table 6-12

REMOVAL ACTION COST ANALYSIS - ALTERNATIVE GW3
EX-SITU BIOLOGICAL TREATMENT
ENGINEERING EVALUATION/COST ANALYSIS
JENNISON-WRIGHT
GRANITE CITY, ILLINOIS

Direct Capital Costs				
Item Description	Quantity	Unit	Cost/Unit	Cost
Field Overhead and Oversight	8	month	\$14,646	\$117,168
Health and Safety	8	month	\$12,887	\$103,096
Mobilization and Demobilization	1	lump sum	\$8,500	\$8,500
Bench Scale Study	1	lump sum	\$10,000	\$10,000
Pilot-Scale Study	1	lump sum	\$50,000	\$50,000
Treatment Building	1	each	\$64,037	\$64,037
Treatment Startup Assistance	1	lump sum	\$3,400	\$3,400
Pretreatment System	1	each	\$14,500	\$14,500
Heat Exchanger, 112 gpm	1	each	\$6,788	\$6,788
BioAccelerator System	1	each	\$185,800	\$185,800
Post Treatment	1	each	\$71,400	\$71,400
Activated Carbon System	1	job	\$3,500	\$3,500
Subtotal Direct Capital Costs				\$638,189
Overhead and Profit (25%)				\$159,547
Total Direct Capital Costs (Rounded to Nearest \$1,000)				\$798,000
Indirect Capital Costs				
Engineering and Design (25%)				\$199,500
Legal Fees and License/Permit Costs (5%)				\$39,900
Construction Oversight (5%)				\$39,900
Total Indirect Capital Costs (Rounded to Nearest \$1,000)				\$279,000
Subtotal Capital Costs				\$1,077,000
Contingency Allowance (15%)				\$161,550
Total Capital Costs (Rounded to Nearest 1,000)				\$1,239,000
Annual PRSC Costs				
Item Description	Quantity	Unit	Cost/Unit	Cost
O & M of Treatment System	52,560	1000 gal	\$0.31	\$16,294
Chemicals (Bionutrients and pH Control)	1	year	\$1,577	\$1,577
Carbon Regeneration	5,500	pound	\$0.05	\$275
Transportation of Sludge to Disposal Facility	0.23	ton	\$43.06	\$10
Off-Site Disposal of Sludge	460	pound	\$0.35	\$161
Off-Site Disposal of Treated Liquid to Sanitary Sewer	70,267	100 cf	\$0.86	\$60,430
Groundwater Monitoring	2	round	\$35,190	\$70,380
Yearly Summary Report	1	lump sum	\$7,392	\$7,392
Subtotal Direct PRSC Costs (Rounded to Nearest \$1,000)				\$157,000
Overhead and Profit (25%)				\$39,250
Administration (5%)				\$7,850
Insurance, Taxes, Licenses (2.5%)				\$3,925
Subtotal Indirect PRSC Costs (Rounded to Nearest \$1,000)				\$51,000
Subtotal Direct and Indirect PRSC Costs (Rounded to Nearest \$1,000)				\$208,000
Contingency Allowance (15%)				\$31,200
Total Annual PRSC Cost (Rounded to the nearest \$1,000)				\$239,000

10 Year Cost Projection (Assumed discount rate per year: 5%)	
Total Capital Costs	\$1,239,000
Present Worth of 10 years PRSC (Rounded to Nearest \$1,000)	\$1,845,000
Total Alternative Cost (Rounded to Nearest \$10,000)	\$3,080,000

Table 6-13

REMOVAL ACTION COST ANALYSIS
 BUILDING ABATEMENT AND DEMOLITION
 ENGINEERING EVALUATION/COST ANALYSIS
 JENNISON-WRIGHT
 GRANITE CITY, ILLINOIS

Direct Capital Costs				
Item Description	Quantity	Unit	Cost/Unit	Cost
Field Overhead and Oversight	3	month	\$14,646	\$43,938
Health and Safety	3	month	\$12,887	\$38,661
Mobilization and Demobilization	1	lump sum	\$9,470	\$9,470
Structure Demolition, Removal, and Disposal (not including floor slabs)	1	lump sum	\$66,056	\$66,056
Demolition, Removal and Disposal of Floor Slabs	1	lump sum	\$28,000	\$28,000
Abatement and Disposal of RACM	1	lump sum	\$35,903	\$35,903
Subtotal Direct Capital Costs				\$222,028
Overhead and Profit (25%)				\$55,507
Total Direct Capital Costs (Rounded to Nearest \$1,000)				\$278,000
Indirect Capital Costs				
Engineering and Design (10%)				\$27,800
Legal Fees and License/Permit Costs (0.1%)				\$278
Construction Oversight (5%)				\$13,900
Total Indirect Capital Costs (Rounded to Nearest \$1,000)				\$42,000
Subtotal Capital Costs				\$320,000
Contingency Allowance (15%)				\$48,000
Total Alternative Cost (Rounded to Nearest \$1,000)				\$368,000

Table 6-14

REMOVAL ACTION COST ANALYSIS
 REMOVAL OF MISCELLANEOUS ITEMS
 ENGINEERING EVALUATION/COST ANALYSIS
 JENNISON-WRIGHT
 GRANITE CITY, ILLINOIS

Direct Capital Costs				
Item Description	Quantity	Unit	Cost/Unit	Cost
Field Overhead and Oversight	2	month	\$14,646	\$29,292
Health and Safety	2	month	\$12,887	\$25,774
Mobilization and Demobilization	1	lump sum	\$9,470	\$9,470
Decontamination Pad	1	lump sum	\$12,799	\$12,799
Cleanout and Transportation of Tanks and Tram Tracks	1	lump sum	\$43,083	\$43,083
Transportation of Oil to Incinerator	68	ton	\$43.06	\$2,928
Off-Site Disposal of Oil (Incineration)	63,050	pound	\$0.23	\$14,502
Off-Site Disposal of Sludge	72,430	pound	\$0.35	\$25,351
On-Site Carbon Treatment of Liquids	35	1000 gal	\$0.55	\$19
Disposal of Treated Liquid to Sanitary Sewer	47	100 cf	\$0.86	\$40
Subtotal Direct Capital Costs				\$163,258
Overhead and Profit (25%)				\$40,815
Total Direct Capital Costs (Rounded to Nearest \$1,000)				\$204,000
Indirect Capital Costs				
Engineering and Design (7%)				\$14,280
Legal Fees and License/Permit Costs (5%)				\$10,200
Construction Oversight (5%)				\$10,200
Total Indirect Capital Costs (Rounded to Nearest \$1,000)				\$35,000
Subtotal Capital Costs				\$239,000
Contingency Allowance (15%)				\$35,850
Total Alternative Cost (Rounded to Nearest \$1,000)				\$275,000

7

Proposed Site-Wide Removal Action Alternative

Based upon the alternative evaluations conducted in Section 6, a site-wide removal action alternative is proposed in this section. For site soils and wastes, a landfarm to be constructed in the northeast portion of the site is recommended (Alternative S&W2). A landfarm is preferred over a soil cover because it is more protective of human health and the environment, and over LTDD and off-site disposal based on cost. LTDD and off-site disposal would be approximately five times more costly than a landfarm.

For NAPL removal, hot water and steam flushing (Alternative NAPL1) is preferred over surfactant flushing because it is a more proven technology. And for the 22nd Street lagoon and PCP process area groundwater contamination plumes, enhanced in situ bioremediation using ORC and air sparing is favored over natural attenuation and ex situ biological treatment. Natural attenuation is not a sufficiently aggressive approach to treat the high concentrations of COPCs in these plumes. Ex situ biological treatment would involve a greater level of design, construction, and PRSC than enhanced in situ bioremediation, and is more costly. Natural attenuation is recommended for the other areas of groundwater contamination on site where the concentrations of COPCs are much lower.

Also included in the recommended site-wide removal action are the removal and off-site disposal of RCRA hazardous waste identified at the site, RACM abatement, building and silo demolition, and removal of the miscellaneous items from the site (e.g., ASTs, USTs, debris piles). Removal of the buildings, silos, and miscellaneous items is necessary to facilitate the implementation of a removal action to address soils and wastes, NAPLs, and groundwater, and is necessary for eventual site redevelopment.

7.1 Construction of the Proposed Site-Wide Removal Action Alternative

Conceptually, the proposed site-wide removal action would occur in the following manner. An engineering design firm would be retained by IEPA to prepare design documents for the removal

7. Proposed Site-Wide Removal Action Alternative

action. As a pre-design effort, additional field investigation would be needed in the vicinity of the 22nd Street lagoon to better define the limits of the NAPLs present beneath this area, and in the vicinity of Geoprobe groundwater sample GP16S (located south of the silos) to confirm the presence of groundwater contamination in this area. Additionally, soil samples from beneath the site buildings would be collected to further delineate the subfloor soil contamination. Concurrent with design preparation, additional bench- and pilot-scale testing would be required to better define the operating parameters of the treatment systems to be implemented. Upon completion of the design documents, additional investigations, and bench- and pilot-scale testing, IEPA would solicit bids and retain a contractor to perform the removal action work.

After mobilization, the contractor would begin work by abating RACM and demolishing the site buildings, foundations/slabs, and silos, and removing RCRA hazardous waste and the miscellaneous items from the site for off-site disposal at appropriate facilities. It is also possible for IEPA to retain a contractor to abate the RACM and demolish the buildings before completion of the design for the remainder of the removal action. This would expedite the removal of these structurally unsound buildings from the site. Liquid wastes in the concrete basin, oil/water separator, and the various pits and sumps would be pumped through a carbon treatment unit and discharged to the sanitary sewer. A fee would be assessed by Granite City for this discharge. Sludge and sediments present in these structures would be removed and stored in a secure stockpile area to await treatment in the landfarm cell. A decontamination pad would be built for cleaning the equipment and miscellaneous scrap metal. Decontamination liquids would be containerized, treated by carbon, and discharged to the sewer.

The contractor would next excavate the top 2 feet of contaminated surface soils in the areas of the site slated for the landfarm cell, soil stockpile unit, and retention pond construction. The excavated soil would be staged temporarily until the soil stockpile unit was constructed. Upon completion of the stockpile unit, the staged soil would be transferred to the unit to await treatment. Construction of the landfarm cell and retention pond would continue until completed. Upon completion of the cell and pond, 11,000 cubic yards of soil from the soil stockpile unit would be placed into the cell in a 12-inch lift, and treatment of this soil would begin. RCRA hazardous waste will be disposed of off-site at a licensed disposal facility and will not be treated by the landfarm cell.

Concurrently with the construction of the landfarm cell, a drilling subcontractor would install approximately eight new 2-inch monitoring wells in the PCP process area. Each well would be screened from 20- to 60-feet BGS to remediate both the shallow

7. Proposed Site-Wide Removal Action Alternative

and intermediate zones of the aquifer. ORC socks would be linked together to form a 40-foot-long chain, and placed into these eight new wells. Shorter ORC sock chains would be installed in wells MW8S and MW8M as the screens in these existing wells are 10 feet in length.

After installation of the new monitoring wells in the PCP process area, the drilling subcontractor would begin installation of the injection and extraction wells needed to implement the CROW process in the 22nd Street lagoon area. Based on the conceptual design prepared by WRI, it is estimated that six injection and two extraction wells would be required in this area in a connected five-spot pattern. Injection wells would be screened at the shallow, intermediate, and deep levels (i.e., 20 to 30 feet BGS, 50 to 60 feet BGS, and 105 to 115 feet BGS), while extraction wells would be screened throughout the entire saturated zone (i.e., 20 to 115 feet BGS).

A treatment shed on a slab would be constructed to house the CROW process treatment equipment (i.e., oil/water separator, heaters, pumps, control systems, etc.). Hot water and steam would be injected into the NAPL-contaminated area at a minimum rate of 90 gpm, with a groundwater/NAPL mix being extracted at a rate of around 100 gpm. The extracted groundwater would pass through the oil/water separator with any recovered oil being containerized for off-site disposal or recycling. Groundwater leaving the oil/water separator would be heated and reinjected into the system at the 90-gpm rate. Excess water (10 gpm) would be run through carbon and discharged to the sewer.

7.2 Post-Removal Site Control

Once the landfarm cell, ORC wells, and CROW process are constructed and have begun operation, the site would enter a period of PRSC. The soil undergoing treatment in the landfarm would require quarterly tilling. Moisture and nutrient addition would be required on an as-needed basis. Upon completion of treatment in the cell, the treated soil would be removed and stockpiled to await final grading across the site. The stockpiled soil will be sampled and analyzed to ensure that it does not exhibit RCRA hazardous waste characteristics prior to final grading across the site. A new lift of untreated soil would then be removed from the untreated soil stockpile unit and placed into the cell. Water in the retention pond would need to be periodically pumped through carbon and discharged to the sewer to maintain an acceptable water level. Cleanout of the drainage system piping would be required on a periodic basis.

In the PCP process area, the ORC socks present in the 10 monitoring wells would need to be changed every six months.

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Used socks would be disposed of in the manner prescribed by the manufacturer.

In the 22nd Street lagoon area, the CROW process would continue to operate for a period of three to four years. It is expected that after this period, a point of diminishing NAPL recovery would be reached, meaning that further recovery of NAPL would not be cost-effective. When this point is reached, the CROW process would be dismantled and removed from the site, and an air sparging system, designed to enhance in situ bioremediation, would be installed in its place. The existing CROW process injection and extraction wells would be converted into air sparging points. Also, an undetermined number of new, small-diameter injection points would likely be required. The system's equipment and controls would be housed in the existing treatment shed.

On a quarterly or semiannual basis (to be determined in the design phase), a round of groundwater samples would be collected from the 21 existing monitoring wells. This sampling would be conducted to monitor the effectiveness of the ongoing cleanup, to monitor the progress of natural attenuation of groundwater in areas of the site not being actively remediated, and to alert the IEPA of a potentially worsening situation which would require a more aggressive cleanup approach.

Throughout the course of the cleanup, the IEPA would issue periodic fact sheets and conduct availability sessions in Granite City to keep the public informed of the progress of the cleanup, and to answer questions and solicit comments from interested parties.

Individual cost estimates were prepared for each removal alternative. In developing a preliminary engineering cost estimate for the proposed site-wide removal action, redundant costs would be included if the cost estimates for the selected removal alternatives were added together. Additionally, multiple construction tasks can be performed concurrently, thereby reducing the overall time frame to implement a site-wide removal action. Therefore, common items such as field overhead and oversight, health and safety monitoring, and mobilization of general equipment were broken out of the individual cost estimates. The preliminary cost estimate for the proposed site-wide removal action is presented in Table 7-1.

Table 7-1

**SITE-WIDE REMOVAL ACTION-COST ESTIMATE
ENGINEERING EVALUATION/COST ANALYSIS
JENNISON-WRIGHT SITE
GRANITE CITY, ILLINOIS**

Alternative	Capital Costs	Present Worth PRSC Costs	Estimated Total Present Worth Cost
Common Items	\$577,000	N/A	\$577,000
Removal and Disposal of Listed Hazardous Waste	\$400,000	N/A	\$400,000
Landfarm (S&W2)	\$1,481,000	\$1,762,000	\$3,243,000
Hot Water and Steam Flushing (NAPL1)	\$1,309,000	\$2,117,000	\$3,426,000
Enhanced In-Situ Bioremediation (GW2)	\$349,000	\$2,151,000	\$2,500,000
Building Abatement and Demolition	\$219,000	N/A	\$219,000
Removal of Miscellaneous Items	\$145,000	N/A	\$145,000
Grand Totals	\$4,480,000	\$6,030,000	\$10,510,000

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